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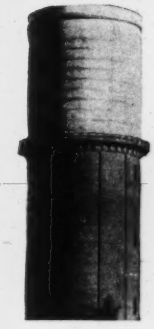

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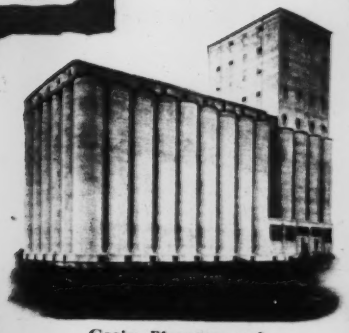

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DEPARTMENT OF DOCKS AND FERRIES
OFFICE OF THE CHIEF ENGINEER

CHARLES W. STANIFORD, CHIEF ENGINEER

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The 3500 tons of Lackawanna Steel Sheet Piling used in the cofferdam for building the foundations and excavating the slips at the shore ends of the 46th Street piers has proven eminently satisfactory in every respect. The maximum length of these steel sheet piling sections was 73 feet, yet driving involved no particular difficulties, the driving costs being very reasonable. The longitudinal, transverse and joint strengths of the individual sections have proven ample to meet our severest requirements.

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Chas. W. Staniford

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Engineering News

VOLUME 75 MARCH 30, 1916 NUMBER 13

Seattle Water-Works Troubles

By Charles Evan Fowler*

SYNOPSIS—Experience with wood-stave supply mains has justified their adoption, notwithstanding lack of proper maintenance. Delays in carrying out plans for additional storage have been due in part to a struggle over municipal ownership of the electric-light and power plant associated with the water-supply and in part to the failure of the city government to follow sound engineering advice. The leaky basin back of the new Cedar River dam should be sealed, a more comprehensive method for maintaining the wood-pipe lines adopted, the wood pipe gradually replaced with steel or concrete, more storage at the city end of the supply lines provided and a separate high-pressure water-supply system constructed for fire protection in the business district.

The history of Seattle's water-works system is of interest to engineers and cities, especially those in the West, due to the varied experiences related in this article.

The Spring Hill Water Co. in 1881 built the first Seattle water-works worthy of the name, and in 1888 Robert Moran, mayor, and afterward builder of the battleship "Nebraska," recommended the purchase of this and other systems and their merger in an adequate city-owned system, most of which was to be built new. The details were covered quite fully in a report of the then city engineer, the late John G. Scurry, and the system was purchased in January, 1890, for $352,266.

The city employed as chief engineer to plan the new system Benezette Williams, who began his investigations in the fall of 1889. While he recommended bringing the water from Cedar River, a distance of 29 mi., his principal recommendation was to empty it into Swan Lake, 17 mi. from the city (see map, Fig. 3), using this as the principal storage and equalizing reservoir. His report stated that the lake would afford a daily storage of 25,000,000 gal. for a period of 70 days, or a total of 1,750,000,000 gal. as compared with the present capacity of about 270,000,000 gal. for all the present reservoirs and standpipes in the city.

The supply main to the city was to be of 42-in. wood-stave pipe coated with two coats of hot asphaltum, which Mr. Williams contemplated as having an indefinitely long life and as costing $7.50 per lin.ft. The estimate at that date for cast-iron pipe was $15 and for steel riveted pipe $10 per lin.ft. The total cost of the proposed system was estimated to be about $1,200,000.

*Consulting Engineer, Central Building, Seattle, Wash.

FIG. 1. CEDAR RIVER MASONRY DAM AND LOWER END OF MORAINAL DIKE ON RIGHT

The business depression of the 90's caused the project to lie dormant until 1895, when surveys and plans were begun for the present system by R. H. Thomson, city engineer. There was appropriated the sum of $1,000 for the engineering work! Nothing daunted, Mr. Thomson put all his regular force to work on the surveys, and they were completed during 1896-97 for the small sum of $8,601.

The great future of Seattle seems to have been fully realized by this engineer, who immediately saw the futility of using Swan Lake at the great additional cost for the then comparatively moderate results obtained and decided upon carrying the entire supply from Cedar River direct to Seattle.

The log-crib dam on Cedar River gives a storage capacity of 5,400,000,000 gal. and the permanent dam 43,000,000,000 gal. The contract was let in April, 1899, for pipe line No. 1 and the Volunteer and Lincoln Park reservoirs, with a capacity of 46,000,000 gal., at about $1,250,000.

Pipe line No. 1 has a length of 28.57 mi., of which 6.82 mi. is of 42-in. steel pipe and 21.7 mi. of untreated wood pipe ranging from 42 to 44¼ in. in diameter for most of its length. This line delivers 22,500,000 gal. per 24 hr., with a velocity of 3.6 ft. per sec. It cost $322,952 and up to 1916 there had been spent in maintenance $128,858, or 40% in 15 yr., as against the estimated cost for renewal of $311,294, or about 65%.

The water department estimated on this rebuilding twice in 45 yr., or the same period as the assumed life of a steel pipe, which was estimated to cost $3,361,352 as against $1,947,595 to be spent in 45 yr. for the wood pipe, figuring interest at 5%. The difference in favor of wood pipe was $1,413,756.

The fact became evident as early as 1906 or 1907 that it would be necessary to increase the water-supply of the city, and the sum of $2,250,000 was spent for pipe line No. 2, for the two Green Lake reservoirs and the twin reservoir on Beacon Hill, with a combined capacity of 220,000,000 gal.

Second Wood-Stave Supply Main

Water was delivered from this line in June, 1909. Its total length is 34.04 mi., of which 5.32 mi. is of steel, principally of 42-in. diameter, and 28.72 mi. of untreated wood-stave pipe, chiefly of 42-, 51½- and 60-in. diameters. The amount delivered by pipe line No. 2 is 41,770,000 gal. in 24 hr., at a velocity of 4.8 ft. per sec. The sum spent on maintenance of this line up to 1916, or a period of 6½ yr., has been only $18,207. This expenditure was abnormally large by reason of nearly $6,000 damage to bridge and line in 1911 and 1912. Leaving out this item, the cost of maintenance has been less than 2% for this period, and it is safe to assume that it will not exceed for the 15-yr. assumed period the 40% charges against pipe line No. 1, as noted above.

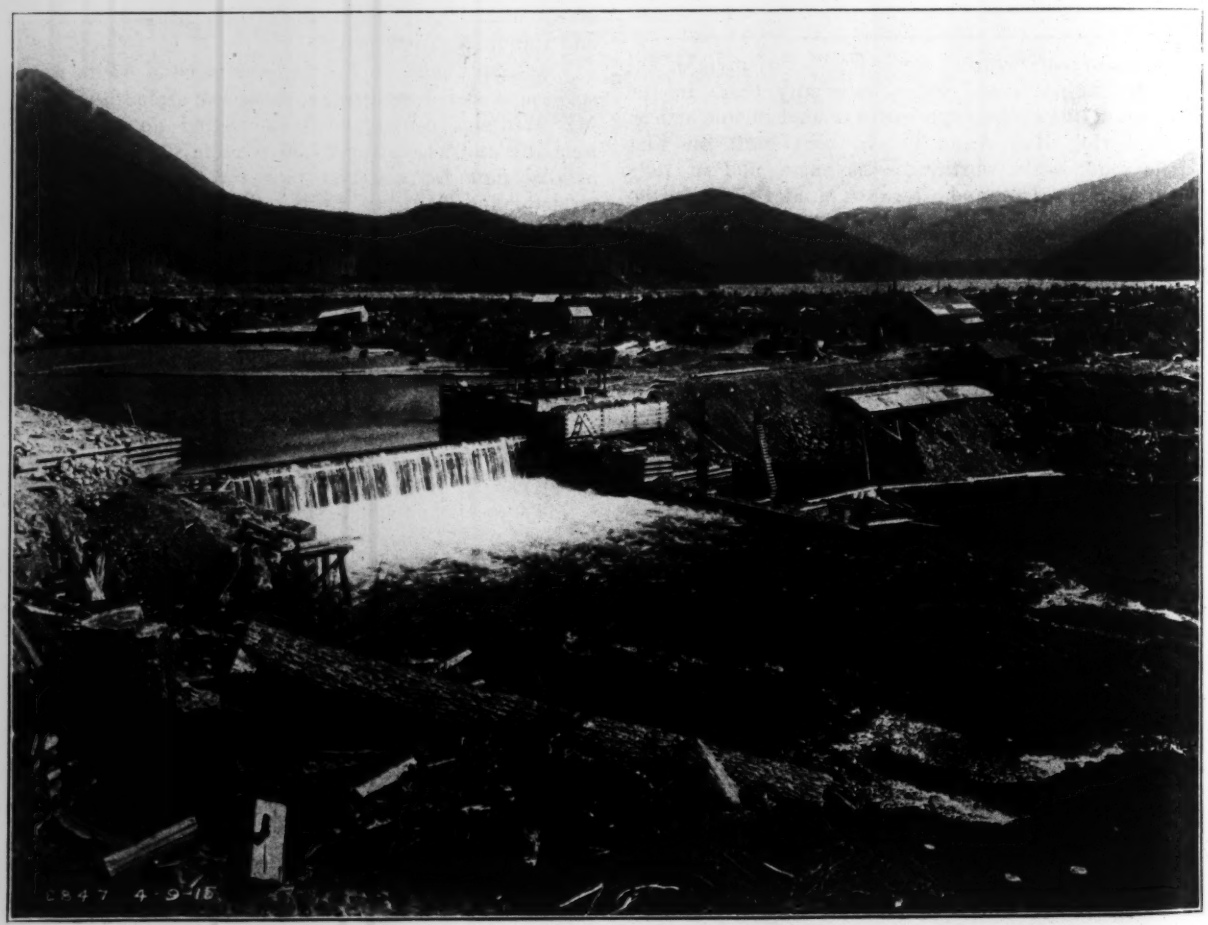


FIG. 2. OLD LOG-CRIB DAM ON CEDAR RIVER AT LANDSBERG; SEATTLE WATER-SUPPLY

These pipe lines both extend from the same intake at Landsburg, El. 535.83, to Seattle and discharge at El. 420. The cost of the pipe has been about as follows per lineal foot:

	42-In.	51½-In.
Staves	$0.85	$1.03
Bands	1.82	2.36
Shoes	.29	.29
Excavation and fill	.55	.72
	$3.51	$4.40

This estimate assumes 25 to 27 staves for the 42-in. pipe, 32 staves for the 51½-in. and three bands ⅝ in. in diameter per foot of pipe. The actual cost of renewing 1,600 ft. of pipe in June, 1913, was $1,330 for labor at $2.75 per day and $1,516 for material. Per foot of pipe this is $0.83 for labor and $0.95 for material, or a total of $1.78.

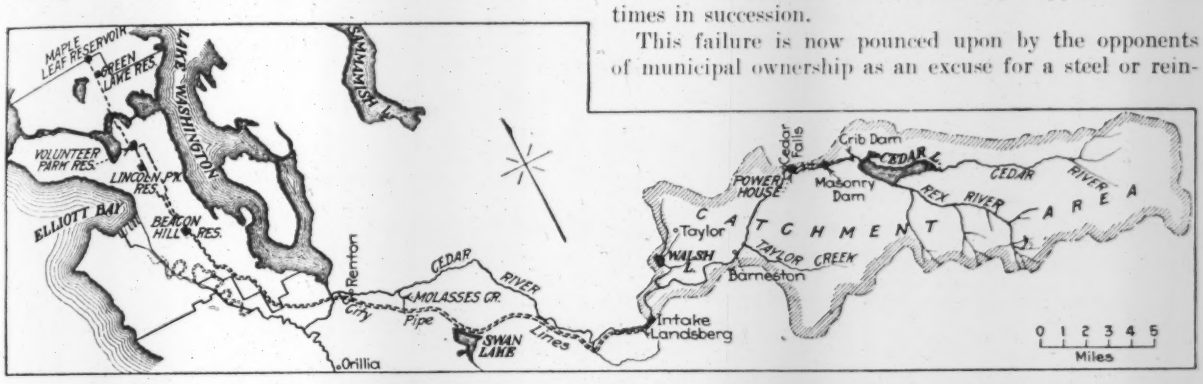


FIG. 3. MAP SHOWING DAMS, PIPE LINES AND RESERVOIRS, CEDAR RIVER WATER-SUPPLY, SEATTLE

Municipal Ownership of Light Plant

The various troubles that have occurred are largely of such a degree as must be expected in any great public enterprise, but they did not become the subject of public controversy until the municipal light plant was built—to generate power and light from the stored waters of Cedar Lake, the plant being located between the dam and the intake of the pipe lines at Landsburg. Since then every happening and proposed expenditure has been the subject of violent controversy between the advocates of municipal ownership on the one hand and the advocates of the private interests on the other hand, with which the city light plant competes for light and power.

The beginning of the great masonry dam (*Engineering News*, Jan. 21, 1915) was long delayed by the fight to prevent an increase in the available power, and the attempt to seal the leaky basin back of the dam is being delayed, it is charged, for like reason. Unquestionably, there is no good reason why an attempt should not be made to seal it, and there is no good reason why it cannot be successfully and cheaply accomplished.

There is danger that the old log-crib dam may fail at any time and let the impounded waters dash against the new dam farther down the cañon. Should that fail as a consequence, then Seattle's water situation would be serious indeed; but the writer is of the opinion that it would stand, and then the leaky basin might make trouble. There is every possibility, however, that in such an event the sediment carried down from the old lake would seal the pervious morainal dike (Fig. 1) and cure this defect.

The break in the pipe lines in November, 1911, when the bridge carrying the pipes across Cedar River washed out, lasted for six days and one hour (see *Engineering News*, Dec. 14, 1911, p. 706). It was permanently repaired with a new bridge and extensive bank protection and is not likely to occur again.

Third Supply Main Not Needed

The recent breaks (*Engineering News*, Jan. 20, 27, Feb. 3, 1916) were the cause of several days' delay and a dangerous shortage of water. They were not caused by the wood pipe primarily, but because the standpipes were frozen up and the pipe could not get air, hence the collapse from external pressure. The workmen failed to learn the lesson, and the same thing happened several times in succession.

This failure is now pounced upon by the opponents of municipal ownership as an excuse for a steel or reinforced-concrete pipe and other reservoirs at a cost of $3,000,000, whereas it is only necessary to effect a more efficient organization for the care, maintenance and repair of the wood pipe. Should this amount be expended, there is little hope for the completion of the basin back of the new dam and the extension of the light and power department from this source for many years, with many sections of the city really suffering for lights.

The recent project would also include the raising of Swan Lake 16 ft., to create a storage basin of 13,500 acre-ft., or 4,410,000,000 gal. This work would entail the construction of the necessary inlet pipes to the lake, the dredging out of the lake, the construction of a dam and of a permanent aqueduct about 17 mi. long into the city. John R. Freeman has already pointed out the possible trouble in getting pure water from Swan Lake and has recommended careful expert study of this question.

Should steel pipes be used for the proposed permanent line, they would collapse under such treatment as was given the wood-stave line; and unless a reinforced-concrete pipe was designed for such a great external load, it too would collapse.

Time for Adoption of Engineering Program

While it is doubtful, judging from past experience, whether the city will take time to have the question properly studied by experts, there is no reason for making the great expenditure proposed, especially under present financial conditions. The real lesson to be learned is the need for a more efficient business administration and one that is closer to the people and single to their interests. The summing up of all the foregoing logically calls for carrying out the following program of betterments:

1. The sealing of the basin back of the new dam at the earliest possible moment, in order to retire the old log-

crib dam, to make available a greater storage and to make available more electrical energy for light and power. This should be done after careful study by expert engineers and the adoption of a definite scheme laid down by them.

2. The gradual replacement of one or both pipe lines by a permanent aqueduct of steel or concrete. This would include the relocation of some parts of the line at danger points, with some of the new line in tunnel.

3. Where repairs are made on the wood-stave lines, some more comprehensive method than is used at present should be adopted for protecting the top surface of the pipe with hot asphalt, as recommended by Benezette Williams, or by some other suitable method—especially at the summits, where air collects and hastens decay.

4. The acquiring of Swan Lake and its watershed, the careful study by experts as to its inclusion in the system and the carrying out of such a plan in the future, when financial conditions are favorable.

5. The immediate construction of an additional reservoir in Volunteer Park and the erection of standpipes for West Seattle and other locations, as needed.

6. The immediate construction of a separate system of high-pressure water mains for fire protection in the business district.

The foregoing outline of betterments is based on the facts that there is nothing vital the matter with the system as it stands, for present needs, and that it is unnecessary and inadvisable at this juncture to spend $3,000,000 for new construction.

Large River Wall of Unusual Design at Cedar Rapids

SYNOPSIS—Reinforced-concrete river wall designed to meet variety of loading conditions. Concrete dumped 20 to 30 ft., then tamped. Wall panels covered by sheet metal. Double stairways to lower walkway, placed between bridges. An ornamental balustrade, the spindle of which can be easily cast.

Two city blocks of heavy reinforced-concrete wall are being completed along the Red Cedar River, at Cedar Rapids, Iowa—from the concrete bridge at Third Ave. to that at Second Ave., and between the latter and an old iron bridge at First Ave. This work is part of an extensive city plan proposed by the local River Front Improvement Commission. A typical section through the wall, Fig. 1, shows it to be of the counterforted type, with a low walk on the river side for the use of boatmen and a high-level walk on the shore side to be used as a walkway. The lower walk is supported on occasional piers and the upper one on brackets extending out from the counterforts. In the design of the wall the stability was investigated under the following assumed conditions:

1. Water to be low, reaching an elevation of 1 ft. below the top of the river sidewalk, and the earth-fill to be level with the top of the upper sidewalk.

2. Same condition as 1, but with a footing of a three-story (basement) building placed 10½ ft. back from the face of the wall and 12 ft. below the top of the upper sidewalk.

3. With no earth-fill behind the wall and with river at an elevation approximately 20 ft. above the bottom of the footing, the drain holes through the wall to be open so that water from the river can rise to the same level back of the wall.

4. Same condition as 3, except that the drain holes are assumed to have been closed so that no water can get from the river to the rear of the wall. This assumes that there would be neither earth nor water back of the wall in this particular case.

The wall is designed to take earth pressure on an angle of repose of 35°, with level fill. A vertical load is assumed of 14,000 lb. per lin.ft. applied 12 ft. below the surface of the upper walk and 10 ft. 6 in. back from the face of the wall, to provide for possible building footings.

The wall is carried on a 2-ft. slab foundation, 15 ft. wide, resting on blue clay. Two projections have been provided to prevent sliding, one at the front and one at the rear edge of the footing. The maximum footing pressure is about 2 tons per sq.ft. The front slab is reinforced front and back, and the footing is reinforced top and bottom, for double pressure. Extensive drainage of ground water is provided by 6-in. vitrified tile placed at the corner of every counterfort and extending from the top of the footing to the top of the wall. Every other length is a tee, the outlet being flush with the rear face of the counterfort and the opening covered with ½-in. mesh copper screen.

An old concrete-building foundation, located just south of the Second Ave. bridge, encroached upon the site of the wall. Either it would have to be blasted out or the wall foundation would have to be modified to include the obstruction. As the footing was 60 ft. long by 6 ft. deep by 4½ ft. wide, it was decided to build over and around it, as shown in Figs. 1 and 4.

Erecting Forms and Placing Concrete

The footings were poured without using sheeting, the blue clay being impervious. An earth coffer-dam had previously been thrown up, with a centrifugal pump (4-in. discharge) to handle the leakage in the foundation pit. First, the bottom was prepared, and the space for the cutoff walls was cut out.

A 1:2:4 mix was used, which included river sand and stone from the local Ellis Park quarry. River sand and crusher screenings were mixed in careful proportions to give a mixture of sand closely approximating Fuller's curve of maximum density. The consistency of the concrete was the usual chuting mix. The concrete for the footings was deposited by chute either directly from the

mixer or by wheeling it in buggies from mixer to chute. The vertical drop was about 26 ft. To overcome resulting separation of the aggregate, a gang of men worked the concrete about with shovels before allowing it to set.

Reinforcement stubs were placed in the footings, to provide for splicing all vertical steel in the main wall. A lap of at least 40 diameters was specified. Whenever this was impossible, which it was in a few instances, the stubs were given better than a 90° hook in the concrete.

Forms for the vertical portion of the wall and for the counterforts were set up on the footing slab after the

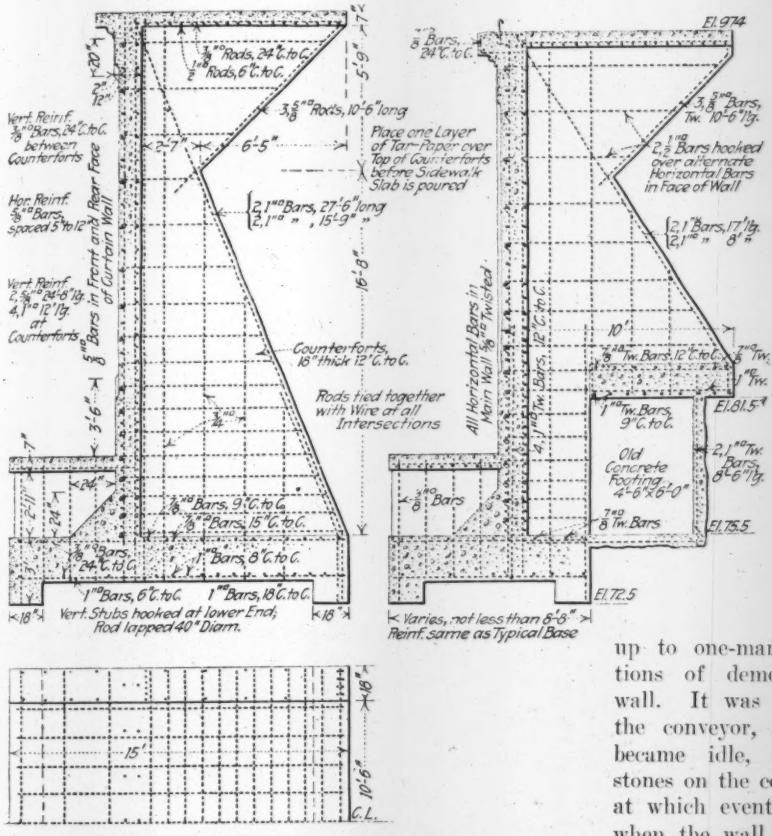

Vert. Reinf. ⅜" Bars, 24" c. to c. between Counterforts
Hor. Reinf. ⅜" Bars, spaced 5 to 12"
Vert. Reinf. 2-⅝" Bars 24'-6" lg. 4-1" Bars 12' lg. at Counterforts
⅝" Bars in Front and Rear Face of Curtain Wall
⅜" Rods, 24" c. to c.
1⅛" Rods, 6' c. to c.
⅝" Rods, 10'-6" long
Place one Layer of Tar-Paper over Top of Counterforts before Sidewalk Slab is poured
2-1" Bars, 27'-6" long
2-1" " 15'-9" "
Counterforts, 18" thick 12' c. to c.
Rods tied together with Wire at all Intersections
All Horizontal Bars in Main Wall ⅝" Twisted
⅝" Bars, 24" c. to c.
El. 97.4
3-⅝" Bars, Tw. 10'-6" lg.
2-1⅛" Bars hooked over alternate Horizontal Bars in Face of Wall
2-1" Bars, 17' lg.
2-1" " 8' "
⅞" Tw. Bars, 12" c. to c.
1" Tw. Bars, 9" c. to c.
Old Concrete Footing 4'-6" x 6'-0"
⅞" Bars
⅞" Tw. Bars
El. 81.5
2-1" Tw. Bars, 8'-6" lg.
El. 75.5
El. 72.5
1" Bars, 6" c. to c.
1" Bars, 18" c. to c.
Vert. Stubs hooked at lower End; Rod lapped 40" Diam.
Varies, not less than 8'-8"
Reinf. same as Typical Base
15'
C.L.

FIG. 1. TYPICAL DESIGN (AT LEFT) AND (AT RIGHT) DESIGN MODIFIED TO AVOID OLD FOOTING

latter had hardened. The bottom of the forms was shimmed to exact level. The forms were made in four horizontal sections, each about 6 ft. in height. They were bolted together, with pipe spacers extending through the concrete, pipe sleeves being used as protection for the bolts and as spacers for holding the forms. The sleeves were left in the finished concrete, the bolts being withdrawn. Where the bolts extended through the face of the wall, a cast-iron building washer was used at the face end of the sleeve. This washer, 3 in. in diameter by 1½ in. thick, was removed with the form, and the hole which it left was filled with mortar of the same consistency as used in the wall. This method left no wires on the surface to rust; but the patched holes gave an unsightly appearance, which, however, improved as the mortar cured. Artificial treatment was used to make the texture of the mortar harmonize with the surrounding concrete.

Sheet metal was placed on the front face of the panel forms. The idea was to change the texture of the face, to accentuate the panel. This procedure was a success where the material adjacent to the metal was not too coarse.

The concreting plant is located near the street, about 200 ft. back from the wall; the concrete is transported to the forms in buggies. Sometimes the concrete is dumped vertically into the forms. At other points it is chuted. The concrete is thoroughly tamped in place by means of long poles. From 48 to 72 lin.ft. of wall to its full height is poured at a run. An insert to take the outer walk is left in the vertical wall, as shown in Fig. 1. The reinforcing steel is placed as the forms for each section are added.

Thirty days are allowed for setting, then backfilling is begun, using the dirt of the coffer-dam in the river. The lower walk is poured before the removal of the coffer-dam. In this walk there is an expansion joint every 24 ft., and the reinforcement steel of the walk is carried into the wall at every other counterfort. The same condition prevails in the case of the upper walk. For the outer walk the concrete is wheeled from the mixer and chuted from the top of the wall. For the upper walk the concrete is wheeled to the site in buggies and dumped and spread.

The muck was lifted to the wall by a home-made ladder conveyor (described in *Engineering News* of Dec. 9, 1915). The coffer-dam contained, in addition to muck, a certain amount of stone up to one-man size, which had formed the foundations of demolished buildings on the site of the wall. It was impossible to handle these stones with the conveyor, so when any of the contractor's men became idle, they were set to work piling these stones on the completed foundation slabs between points at which eventually would be the counterforts. Thus when the wall had risen to its full height, the stones were located on the land side and did not have to be disturbed. The earth-fill, handled by the conveyor, covered them. The rocks had been moved a few feet horizontally with less effort than would have been required had they been left until the wall was completed and then lifted 23 ft. and dropped or piled behind the wall.

Double stairways are placed in the face of the wall midway between bridges, to give access from the lower walk to the upper walk (10 ft. wide). This location was adopted because it was believed that travel would be deflected along the wall in front of the stores and thereby add to the value of the river frontage. Fig. 4 shows how new building footings are constructed as part of the wall. This detail will save property owners from going to the expense and inconvenience of sinking piers to good bearing through the filled material, when they wish to erect buildings fronting the river. A balustrade with an ornamental and easily constructed concrete spindle was adopted after careful consideration. This type of balustrade does not provide for surplus drainage of

FIG. 2. CHUTING FOUNDATION CONCRETE OFF FIRST ST. BRIDGE; WALL FORMS IN FOREGROUND

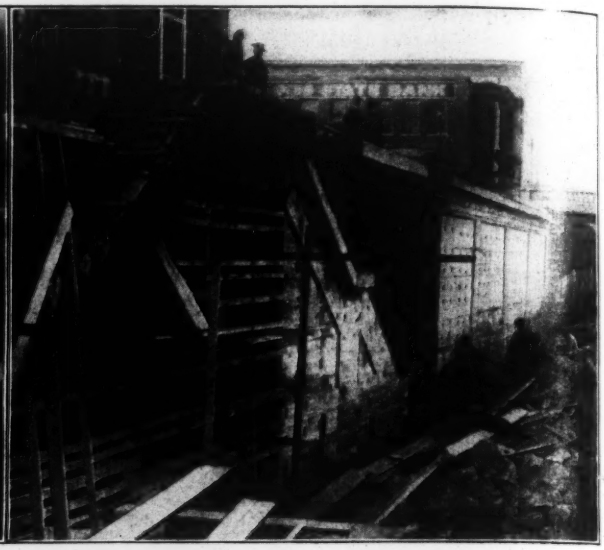


FIG. 3. FORMS IN PLACE FOR CONCRETING STAIRWAY; SECOND ST. BRIDGE IN DISTANCE

the upper walk, on account of the continuous lower chord of the rail. Drainage was provided by placing cast-iron boxes in the lower chord and making connections between them and the ground drain at every other counterfort, or in every bay. The spindles, which are unusually well made, were cast in Cedar Rapids.

River-improvement work had been contemplated in Cedar Rapids for a number of years. The first commission was appointed by the governor in 1902. Its initial work was the location of the meander lines. The first funds were obtained in 1905, by the sale of lands to the Chicago & Northwestern Railway Co. After running the meander lines the problem was to determine the necessary channel width.

The river wall is being built partly by funds provided through special assessment of abutting property and partly through general taxation, being paid from the taxes levied to support the work of the River Front Improvement Commission of Cedar Rapids, whose members are T. H. Simmons, chairman; E. E. Richards and T. R. Warriner. The original engineering design was worked out by Howard R. Greene, of Cedar Rapids. M. L. Fox was in charge of the engineering in the field. The contractor is Frank K. Hahn, of Cedar Rapids.

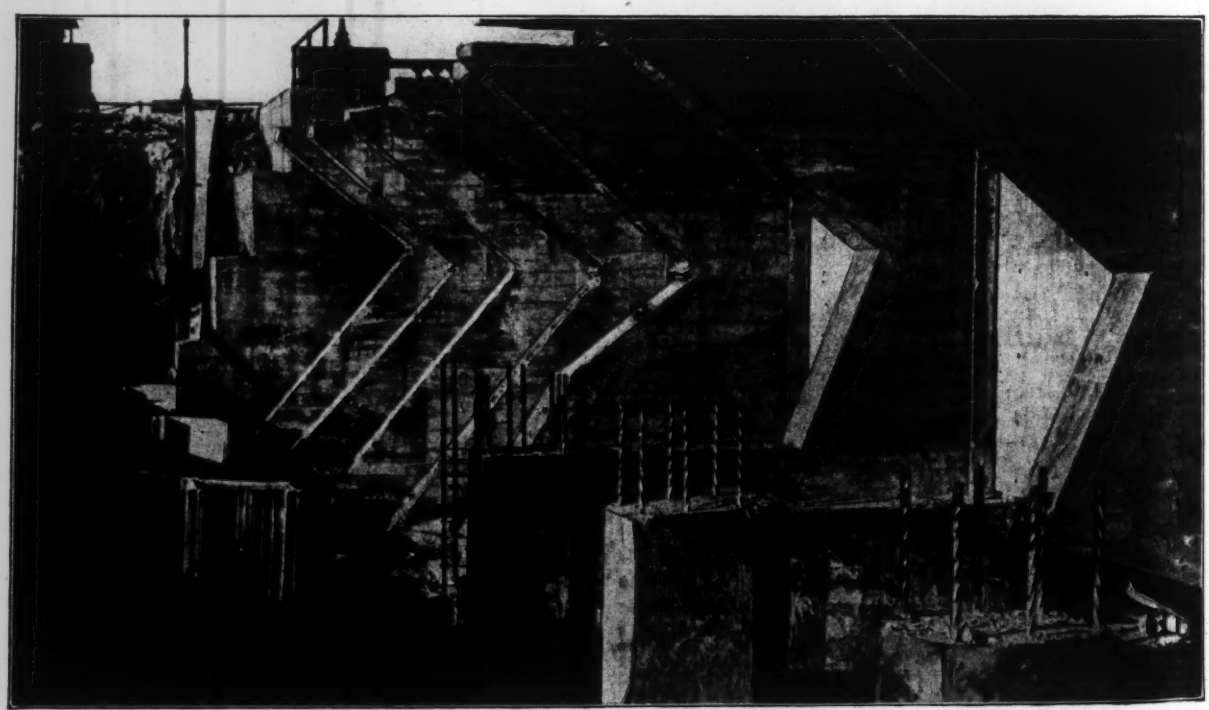


FIG. 4. REAR OF SECTION OF WALL BUILT ACCORDING TO MODIFIED DESIGN SHOWN IN FIG. 1

Footings in the foreground are incorporated in wall foundation, and are intended to help support future buildings fronting the walk on top of wall

Layout of Street Intersections on Steep Grades

The establishment of grades at street intersections is often a difficult matter in a hilly city, such as Duluth, Minn. The methods there employed were described by John Wilson, civil and sanitary engineer, in a paper read at the annual meeting of the Minnesota Surveyors and Engineers Society, Feb. 12. The methods are slightly modified from those proposed some years ago by Andrew Rosewater and Rudolph Hering, employed by the city as consulting engineers.

If the grade is 2% or less (Rosewater and Hering allowed 3%), it is carried across the intersection without breaking. If the grade exceeds 2%, but is not more than 8%, it is broken at the curb line and carried across the intersection on a 2% grade. If the grade exceeds 8%, it is broken at both the curb and property lines. In the business section the grade between the curb and the property line is limited to 5%, in order to avoid the transverse slope of one sidewalk being toward the building or that of the other exceeding 10%.

In the business district the elevation of the sidewalk at the building corner is determined by adding 2% of the distance between the curb and the building line to the elevation of the curb opposite and then taking the mean between these two elevations, provided the elevation thus determined is not less than that of the higher curb. In the residence district there is no advantage in establishing the grade of the property corner.

As the elevation of the center of the street will depend upon the crown of the pavement selected, this elevation should be used only in determining the elevations of the curbs and should not appear on the established grade, unless the center-line profile only is established. In the latter case the curb grades must be made to conform with the center grade and the character of the improvement. However, as sidewalks are usually the first improvement on a street and the property owners improve their front to conform with the walk, the first method is preferable, notwithstanding the uncertainty in assuming a width of pavement.

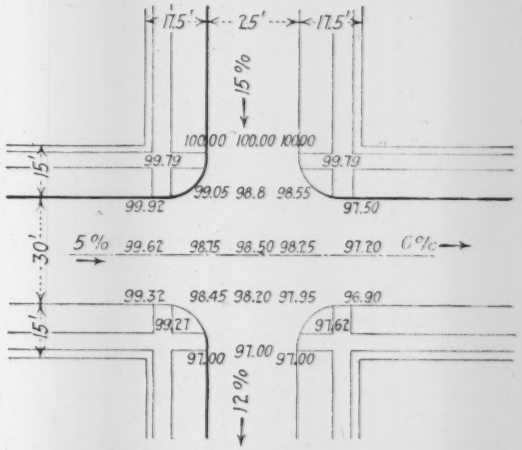
The method of establishing the curb and sidewalk grades in the residence district is best explained by a typical case. Assume that the intersecting streets are both 60 ft. wide and that the distance between the curbs is 25 ft. on the steeper street and 30 ft. on the other. This leaves 17½ ft. between the curb and the property line in the first case and 15 ft. in the second case, as shown on the accompanying plan.

The grades on each side of the street intersection of the street having the steeper grade exceed 8% and are therefore broken at both the property line and the curb line. The grades on the other street, being less than 8%, but more than 2%, are broken at the curb line only. The center-line grades of both streets are now computed. As the street having the steeper grade is practically at right angles to the contours, it will be an advantage to fix the elevations of the curbs on the two sides of the street at the same height. On the other street the cost of construction can be decreased and the improvement made to conform more nearly to the adjoining property by making one curb higher than the other.

The elevation of the curb on the steeper street is taken from the elevation of the center of the street opposite, while the elevation of the intersection of the property line extended and the curb on the other street is determined from the elevation of the intersection of the curb extended with the center line of the first street. This gives a fall of 2% across the hillside street, or the street parallel with the contours.

If the pavement selected on the latter street has but little crown or is of a slippery character, the curb on the upper side of the street is made 10 in. and the curb on the lower side 6 in. high. The crown of the street may also be placed at the third point instead of in the center. The elevation of the intersection of the outer edge of the sidewalk is made higher than the elevation of the higher curb by an amount equal to 2% of the width of the grass space, and the discrepancy with the lower curb is taken up in the grass plot.

In some cases on the lower side of the street the sidewalk is placed below the curb. This should not be more



PLAN OF INTERSECTION OF STREETS HAVING STEEP GRADES

than 8% of the width of the grass plot, in order to avoid the appearance of a sag in the walk. Where the transverse slope of the walk at the intersection will be excessive by this method, the walk grade is broken at a point 25 ft. from the curb and is made to meet a mean elevation, as in the case of a business district, except that the elevation of the walk may be less than that of one of the curbs.

Tests of an Escalator of the Cleat Type, in use at the Washington St. station of the Boston subway, are described in the report of the Boston Transit Commission for 1915. There are two escalators at this station, one for each platform. The escalator leading to Chauncy St. has a vertical lift of about 34 ft. and was subjected to a full-load test by carrying passengers averaging 140 lb. each at the rate of 7,200 per hr. for three consecutive hours. The escalator is located close beside one of the station stairways, and the men employed to make the test rode up on the escalator and walked down the stairways. With 336 men it was possible to keep the escalator continuously loaded with approximately its full specified load. The total load lifted by the escalator during the test was 20,112 men, averaging 153.9 lb. This work was done in three hours, or at the rate of 1,031,745 lb. per hr. This exceeded the contract requirement by about 2.35%. In a maximum of 20 min. of service the escalator hoisted passengers at the rate of 7,782 per hr., or 1,197,650 lb. per hr., exceeding the contract requirement by about 18.8%. The efficiency of the escalator, or the ratio between the horsepower actually required to lift the men and the horsepower received over the feed wires of the control apparatus, was found to be 72%, or 10% in excess of the contract guarantee. The contract price of both escalators, which were furnished by the Otis Elevator Co., was $25,725.

Building 22 Mi. of Pipe Sewers Under One Contract

SYNOPSIS—Close preliminary estimates required many test borings. Trenching machines used throughout, sometimes in narrow alleys. Careful personal supervision by contractor. Cost data given.

In Topeka, Kan., there is under construction at present 22 mi. of vitrified-pipe sanitary sewers. The work is all under one contract, which was let Aug. 10, 1915, and will be completed by June 1, 1916. The district in which these sewers are being built is known as the East Side and contains 7,000 city lots, each approximately 20x150 ft. in size. The soil of practically this whole section is a sticky black gumbo, with some stretches of sandy loam. There is only 198 cu.yd. of rock excavation in the estimate of the entire 22 mi. The sewer system was planned and is being constructed under the supervision of A. R. Young, city engineer. The contractor is James A. Pringle, of Topeka. The estimated cost of the work, including engineering expenses, is about $130,000.

Preliminary Investigations and Design

Money for sewer construction in Topeka is obtained by assessments for benefits; but the property owners are allowed a term of years in which to make the payments, so that the actual construction costs are met by a bond issue the amount of which must be based on accurate estimates. Hence, in addition to the usual surveys test borings were made every 100 ft. throughout the length of the proposed sewers. Where indications of rock occurred, the borings were made every 25 ft.; and in rock, every 5 ft.

This work required the services of 7 men at $2 a day for 20 days, a total of $280, but it eliminated all gamble on the amount of rock excavation. In work so far done, rock has never been encountered at depths varying more than 2 in. from the depths shown by the test borings. Mr. Young believes that similar systematic borings should be made a part of all sewer surveys and recommends that the borings be made by core drills. On this work, hand augers were used.

The design of these sewers was based on the assumption of three people to a lot (21,000 people in all), an average water consumption of 100 gal. per capita per day, with a maximum consumption of three times this. No laterals are less than 8 in., and the mains are designed to take the maximum flow of the laterals plus an allowance of 20% for infiltration, leakage at manhole heads, etc. The pipe used varies from 8 to 45 in. in diameter. The following are the minimum grades: For 8-in., 0.32%; 10-in., 0.24%; 21-in., 0.16%; 45-in. (which is a combined sewer), 0.1%. The intermediate sizes, 15- and 18-in., have minimum grades of 0.16%. In the 22 mi. are 98 flush tanks of the Miller automatic siphon type and 248 manholes.

The minimum depth of cover is about 8 ft., or 9 ft. below the tops of the house basements. The depths run from 8 to 25 ft. The total amount of excavation is about 96,000 cu.yd. The greatest part of the work is in alleys, for Topeka, like many other Middle Western cities, is laid out with an alley (12 to 20 ft. wide) in the middle of each block, lengthwise of the blocks. The householders generally begin sanitary improvements by connecting their outhouses or privies to the sewer, so that there is a considerable popular demand for alley sewers. There is a saving to the city, for there is less interruption to street traffic and many cuts in pavements are prevented. The streets are generally well paved, while the alleys are not. Water and gas mains are laid in the streets, though this often requires destroying a pavement.

The use of the alleys for sewers makes it possible for

FIG. 1. TRENCHING MACHINE WORKING IN A 14-FT. ALLEY, TOPEKA, KAN.

the contractor to do almost all the excavation by machine, for there is no interference with other underground structures except at street intersections. Before a street having water and gas mains is crossed, these pipes are accurately located by the contractor, and the trenching machine is so operated as to avoid them. Where it can be conveniently done, the gas mains are uncovered, a length of pipe taken out and the trenching machine run past, which can be done without shutting off the gas for more than half an hour. Street-car tracks are crossed in the same manner. The contractor, Mr. Pringle, states that he has encountered no difficulties with the public-service corporations in carrying on this work.

FIG. 2. ALLEY THROUGH WHICH A TRENCHING MACHINE HAS OPERATED; MANY BUILDINGS HAD TO BE MOVED

The contractor is doing the work very expeditiously with two Austin trenching machines and two backfilling machines of the same manufacture. One trenching machine digs a trench 3½ ft. wide up to 16 ft. in depth, and the other a trench 4½ ft. wide up to 25 ft. deep. The average day's run with each machine varies from 200 to 500 ft. of trench. The best record was 1,050 ft. in a working day of 9 hr. Some difficulty is experienced in going through narrow alleys. These are public highways and their legal width is 20 ft., but there are many encroachments by barns, sheds and other outhouses, so that the actual clearance in some instances is not more than 12 ft. The trenching machine requires a clearance of 14 ft. to do its work. Consequently, the contractor is often required to move buildings, telephone poles and other obstructions—and move them back again. This, Mr. Pringle assured the writer, was not difficult to accomplish, as he moved the buildings first and in case of dispute settled with the owner afterward. But by handling the work diplomatically he has had no serious disputes or difficulties. His total bill for damages does not exceed $100. He has forbidden his workmen to have any words with property owners and attends personally to all such cases. It is hardly believable that a trenching machine could get through some of the alleys, such, for instance, as are shown in Figs. 1 and 2.

The contractor's methods of operation are as follows: There is a foreman who directs the course of the machine and the pipe laying; one man precedes the machine and levels the ground for its movement; one man operates the machine, doing his own firing; the foreman already mentioned sets the batters; one man in the trench follows the

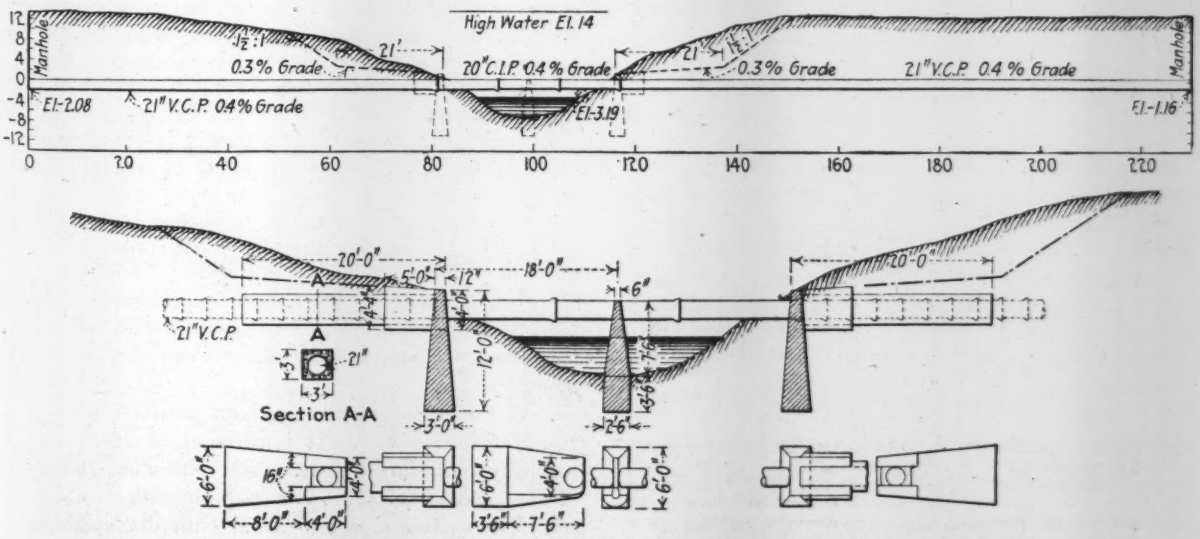


FIG. 3. PROFILE ELEVATION AND PLAN OF CREEK CROSSING OF 20-IN. SEWER AT TOPEKA, KAN.

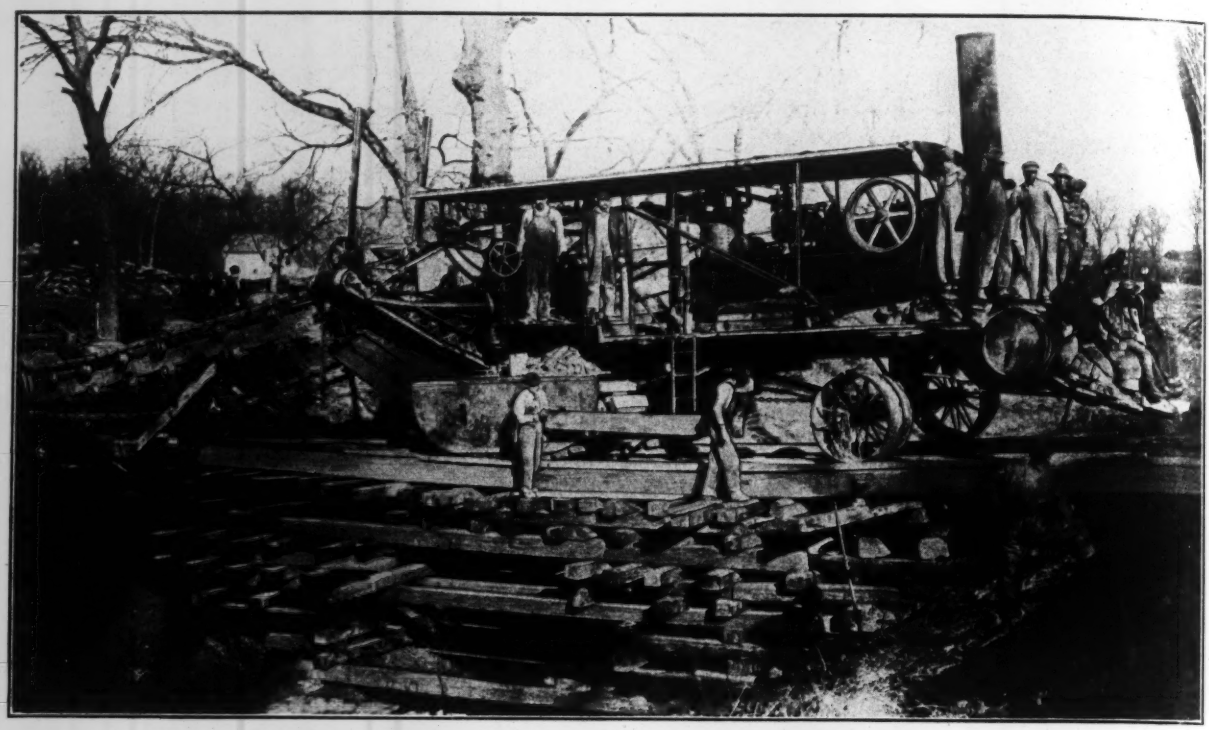


FIG. 4. TRENCHING MACHINE CROSSING CREEK, TOPEKA, KAN.

machine, cleaning up the trench by shoveling the loose material into the buckets and putting in the lower jacks and braces; one man above works with the one in the trench, setting the upper braces; two pipe layers work in the trench and two on the surface (a tripod is used for lowering the pipe); two men follow the pipe layers, taking out the jacks and braces and tamping earth around the pipes. Then come the backfilling machine and a clean-up gang, the size of which depends on the work to be done.

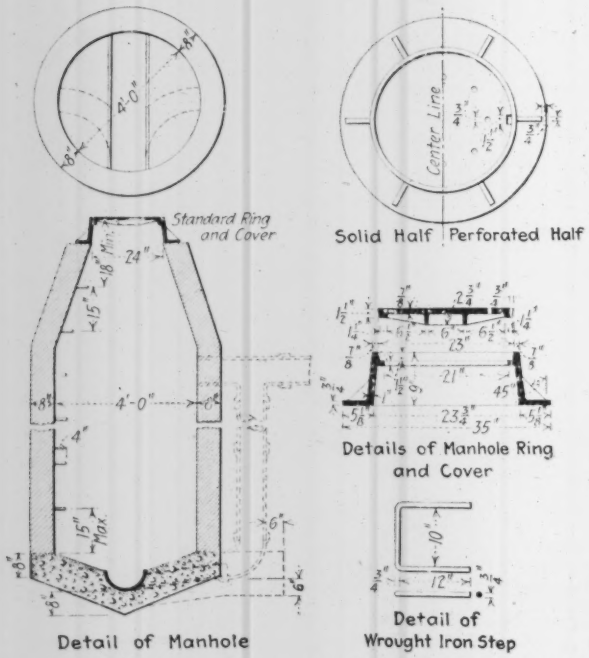


FIG. 5. DETAIL OF SEWER MANHOLES, TOPEKA, KAN.

The average force with each trenching machine is 25 men, and the excavation alone can be done as cheaply as 8 or 10c. per cu.yd. The backfilling costs more. The contractor acts as his own general superintendent. The foremen receive $35 a week and the machine operators $25. It has been found that the pace of the whole outfit is set by the trench speed of the pipe laying, because the specifications do not allow more than 300 ft. of open trench, so the contractor pays the men engaged in pipe laying a bonus of 1c. per section of pipe laid over a certain weekly minimum. While this practice often means an actual loss in this item, the work as a whole is much expedited.

An instrumentman is continually on the work, and every length of pipe is set by an engineer's level. There is no complicated system of batter boards—a single cord for alignment is all that is required. This method has worked out so satisfactorily that it is recommended by Mr. Young even where the contractor has to employ his own instrumentman.

In backfilling, the earth is placed in layers of not over 9-in. thickness until there is a cover of not less than 2 ft. over the top of the pipe. This material is thoroughly rammed. About this level the backfilling is consolidated by puddling. In the narrower alleys the backfilling machine cannot be operated efficiently. At least 6 ft. of space on one side of the trench is necessary. Usually the backfilling is completed not over 150 ft. behind the trenching machine, and the distance is never more than 300 ft.

A very ingenious device has been provided to keep the trench free of water. It consists of an ejector pump made by extending a 1-in. steam pipe down the boom of the trenching machine to a coupling with a 3-in. steam jet. The suction pipe is 3 in. and the discharge pipe 2 in. Whenever the water accumulates in the bottom of the

trench, the machine is stopped for a few minutes and the steam jet operated.

Another item in the routine, which has much to do with the systematic progress of the work, is the proper distribution of the pipe ahead of the trenching. To accomplish this, the contractor takes a blueprint plat of the sewer and marks in red pencil at the places where they are to be delivered the number of sections of pipe, Y's, etc., to be left there. The hauling of the pipe is done by a local teamster for 40c. per ton, the average haul being about one mile.

Details of Design and Cost Data

Some of the most interesting details of the design are shown in Figs. 3, 5 and 6. The creek crossing shown in Figs. 3 and 4 is of 20-in. cast-iron pipe on concrete piers. The crossing is at the grade of the sewer. Fig. 4 shows

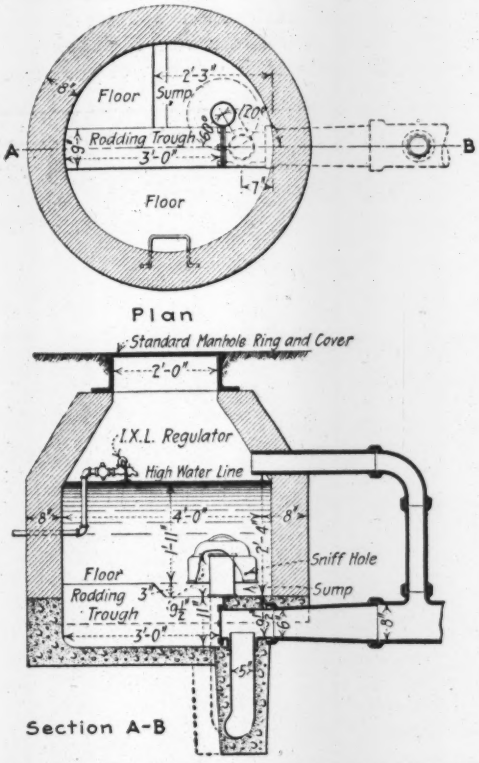


FIG. 6. DETAIL OF AUTOMATIC FLUSH TANKS, TOPEKA SEWERAGE

the trestle built to take the trenching machine over the creek at this point. There was no highway bridge strong enough to carry the machine, so the contractor built his bridge on the line of the sewer, working with it into both banks. Figs. 5 and 6 show the details of the automatic flush tanks and of the manholes. Manholes of concrete of the same design have proved very satisfactory in other parts of the city.

The accompanying tabulation shows the city engineer's estimate and the successful contractor's bids.

ESTIMATES AND SUCCESSFUL BIDS ON TOPEKA SEWER WORK

Item	Estimate		J. A. Pringle	
62,770 ft., 8-in. V. C. Pipe	$0.65	$40,800.50	$0.60	$37,662.00
22,543 ft., 10-in. V. C. pipe	.76	17,132.68	.75	16,907.25
10,966 ft., 12-in. V. C. pipe	.95	10,417.70	.87	9,540.42
4,682 ft., 15-in. V. C. pipe	1.52	7,116.64	1.46	6,835.72
3,988 ft., 18-in. V. C. pipe	1.67	6,659.96	2.00	6,976.00
2,947 ft., 21-in. V. C. pipe	2.44	7,190.68	2.46	7,249.62
2,992 ft., 24-in. V. C. pipe	3.96	11,848.32	3.90	11,668.80
281 ft., 27-in. V. C. pipe	5.50	1,545.50	4.68	1,315.08
36 ft., 20-in. c.-i. pipe	5.00	180.00	5.00	180.00
33,100 ft., 1-in. galvanized pipe	.20	6,620.00	.20	6,620.00
98 flush tanks	65.00	6,370.00	65.00	6,370.00
248 manholes	45.00	11,160.00	45.00	11,160.00
200 cu.yd. concrete	7.00	1,400.00	8.00	1,600.00
25 M. b.m. sheeting	30.00	750.00	30.00	750.00
Extra excavation	50.00	.....	.50	.....
Total		$129,191.98		$125,834.89

Owing to the fact that the assessments cover all costs 4% of the contract price is withheld from the contractor to pay the engineering costs. The contractor is permitted to make house connections for property owners at a stipulated price.

Reversing Currents Prevent Underground Electrolysis

Corrosion of pipes and other buried structures by stray currents is practically negligible when the current reverses once a minute or more often. This conclusion was drawn from a series of studies by the United States Bureau of Standards into the effect of alternating currents on soil electrolysis. The results of the investigation were presented by Burton McCollum and G. H. Ahlborn on Mar. 10, before the American Institute of Electrical Engineers, New York City, in a paper entitled "Influence of Frequency of Alternating or Reversed Current on Electrolytic Corrosion."

The finding is of importance, for the use of the insulated negative-feeder system of reducing stray currents usually brings an extended "neutral zone" where the potentials of pipes, etc., to ground are small and reversing. In the case of iron no appreciable corrosion was found with alternating currents of between 15 and 60 cycles per second, but no such limit was found for lead. The addition of sodium carbonate to soil reduces the corrosion of iron and increases that of lead. Corrosion of iron reaches its maximum value when the current-reversal cycle occupies more than two weeks; with lead the maximum corrosion is reached with a frequency of reversal between one day and one week.

These phenomena are explained by the fact that the corrosion actions are largely reversible—the metal dissolved during one-half cycle being redeposited on the reversal. This metal may have little value mechanically, but serves as the anode surface and protects the main material from attack.

At the same meeting (held jointly with the New York Section of the American Electrochemical Society) Prof. W. H. Walker, Massachusetts Institute of Technology, presented a paper dealing with the corrosion of metals more generally. Of interest in connection with the preceding paper was Professor Walker's statement that the freedom of copper-steel from corrosion (weathering) is due to the formation of a protecting layer of oxide. Dr. A. S. Cushman, Washington, D. C., in discussion referred to experience with over 300 test pieces of copper-steel weathering in Arizona. He claimed that these showed that the copper had nothing whatever to do with the results, which depended on the nitrogen content of the metal.

A Road-Traffic Census is to be made in St. Louis County, Missouri, before deciding what type of road improvement to carry out with the bond issue voted a few weeks ago. The County Court has arranged with the Federal Government to have the census supervised by highway engineers from the Department of Agriculture. A consulting engineer on road improvements will be appointed by the county authorities.

Four-Span Steel-Arch Bridge at Indianapolis, Ind.

SYNOPSIS—This bridge has spans of 192 ft., with plate-girder arch ribs supporting spandrel columns to carry the deck framing. A traveler on the deck drove falsework and set steel within its reach and then moved forward to place the next portion of falsework and steel.

A steel arch bridge with four spans of 192 ft. has been built at Indianapolis to carry West New York St. across the White River. It is on a skew of 54° 17′ with the river and has a length of 792 ft. between abutment faces. It has a 24-ft. roadway (without car tracks) and two 8-ft. cantilevered sidewalks. The live-load specifications provide as follows: For the roadway, 150 lb. per sq.ft. and a 15-ton road roller; for the sidewalks, 100 lb. per sq.ft.; for the ribs, the same as the roadway plus 5,000 lb. concentrated at points giving maximum and minimum moments. The calculations were made for the middle rib, and the three ribs were built to the same design.

The bridge was designed by Frederick H. Burnette, of Indianapolis, as consulting engineer for Paul Julian, County Surveyor. The contract was let to the Central States Bridge Co., which sublet the substructure and concrete work to the American Construction Co., both of Indianapolis. A view of the partly completed structure is shown in Fig. 1.

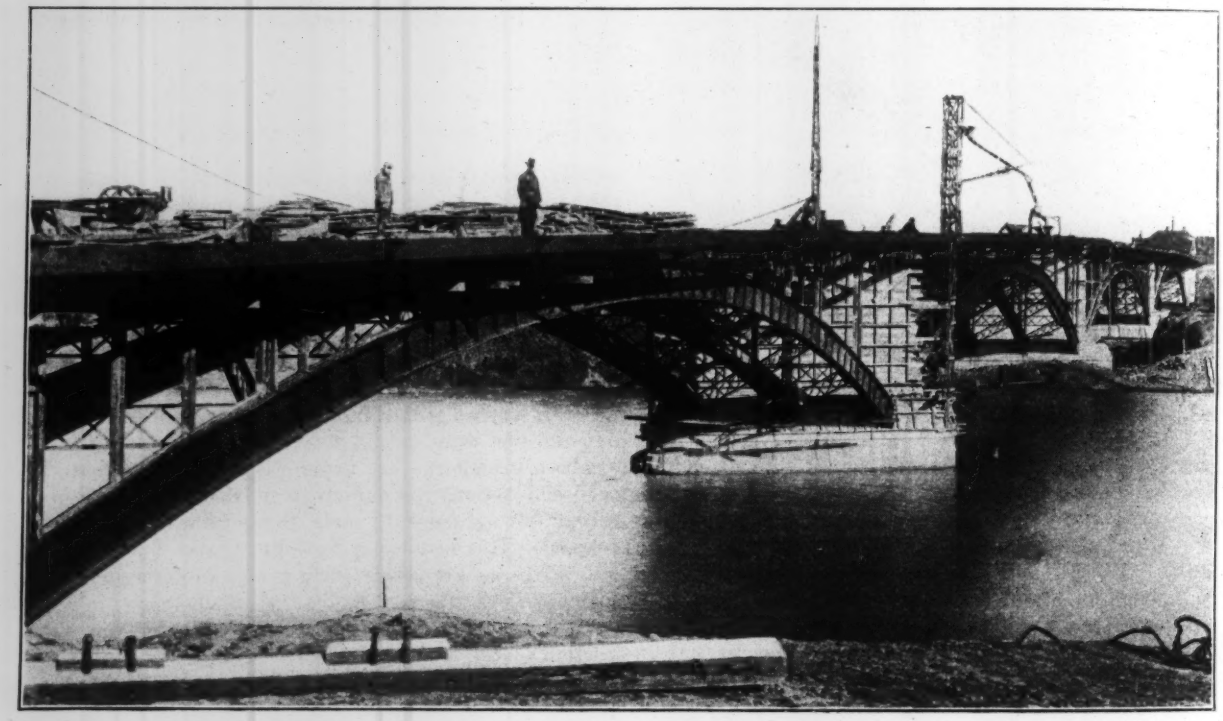


FIG. 1. STEEL ARCH BRIDGE OVER THE WHITE RIVER AT WEST NEW YORK ST., INDIANAPOLIS, IND.

Each span consists of three plate-girder hingeless arch ribs, with radial stiffeners and splices. The ribs are shaped to a parabolic curve, with a rise of 21 ft. 9 in. above the springing, are spaced 12 ft. apart and are connected by transverse and diagonal lattice trusses framed between the webs. The construction is shown in Figs. 2, 3 and 4.

The ribs were calculated as having fixed ends, and their supports were made very heavy to insure this condition. At the piers the ribs are riveted to plate-girder skewbacks on steel bents, or towers, that are anchored to the foundation concrete and afterward embedded in the concrete of the upper part of the piers. The skewbacks have projecting cover plates that lap over the chords of the ribs, as shown. At the abutments the ends of the ribs are riveted to heavy steel anchorages. The expense of this construction was considered well warranted, in order to obtain a very high safety factor at these critical points in the design of the structure.

Upon the ribs are spandrel columns (8-in. H-beams) supporting three longitudinal lines of 20-in. I-beams, between which are framed 12-in. tranverse I-beams 5 ft. apart. Each sidewalk is supported by 8-ft. cantilever brackets 19 ft. 2 in. apart, carrying an outer line of 12-in. channels. Between pairs of cantilevers are two intermediate supports consisting of 6-in. I-beams framed against the outer channel and resting on top of the 20-in. longitudinal I-beams.

This floor framing, which is shown in Fig. 4, is all incased in concrete and supports a reinforced-concrete slab. The sidewalk slabs are finished to form the wearing surface, while the roadway slab is covered with asphalt paving.

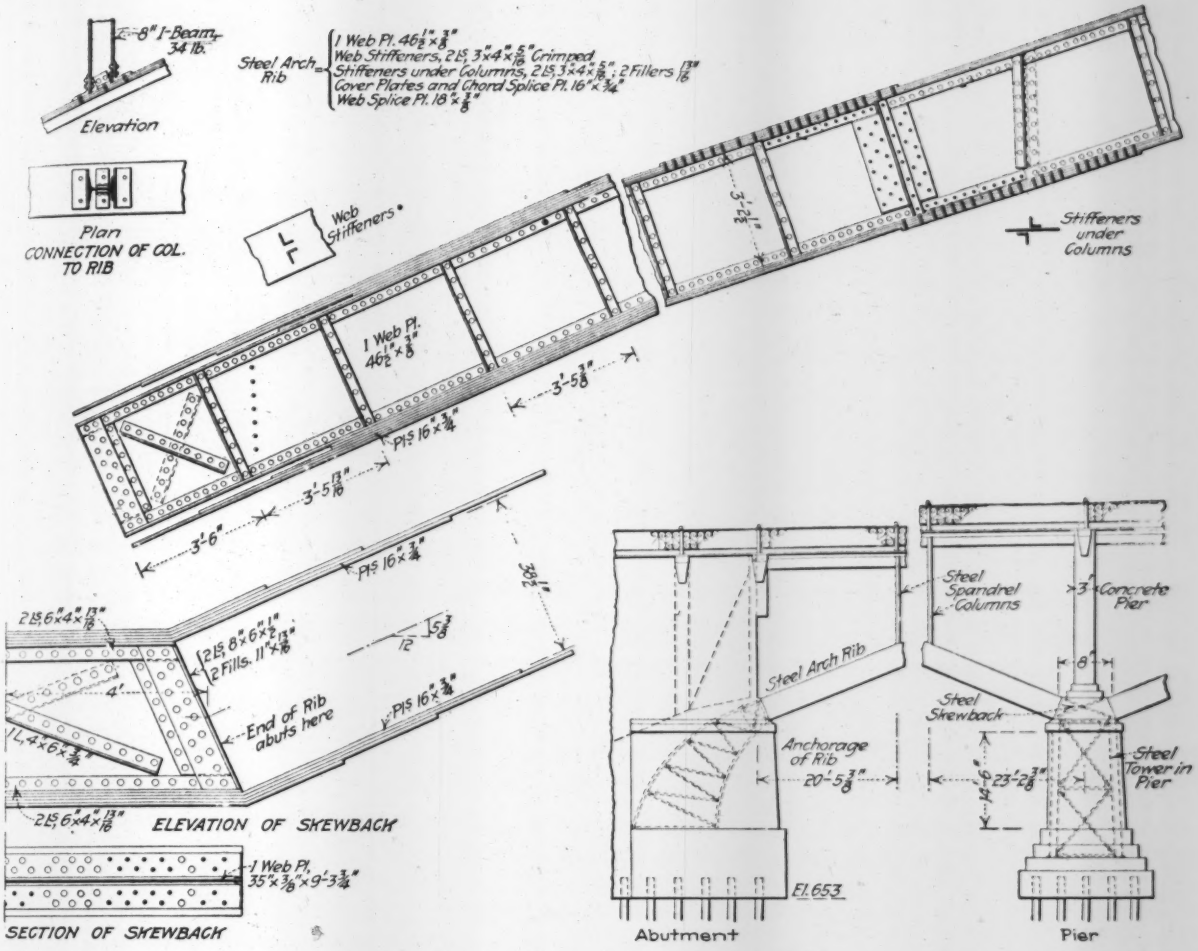


FIG. 2. STEEL ARCH RIBS AND SKEWBACK GIRDERS ON PIER

FIG. 3. ANCHORAGES AND TOWERS IN ABUTMENTS AND PIERS

The piers and abutments are of concrete, with pile foundations. The steel arch ribs are not supported directly by the concrete, but by the steel anchorages in the abutments and the steel towers in the piers, as already explained. The concrete of the main body of the piers and abutments was placed after the erection of the steel. Pockets were left for the projecting parts of the steel skewbacks and anchorages, and these pockets were filled with concrete when the steel ribs had been placed and riveted.

After the erection of the steel a 30-in. wall was carried up above the top of the pier proper to the level of the deck. The abutments are carried up in the same way. They have straight vertical wing walls, with coun-

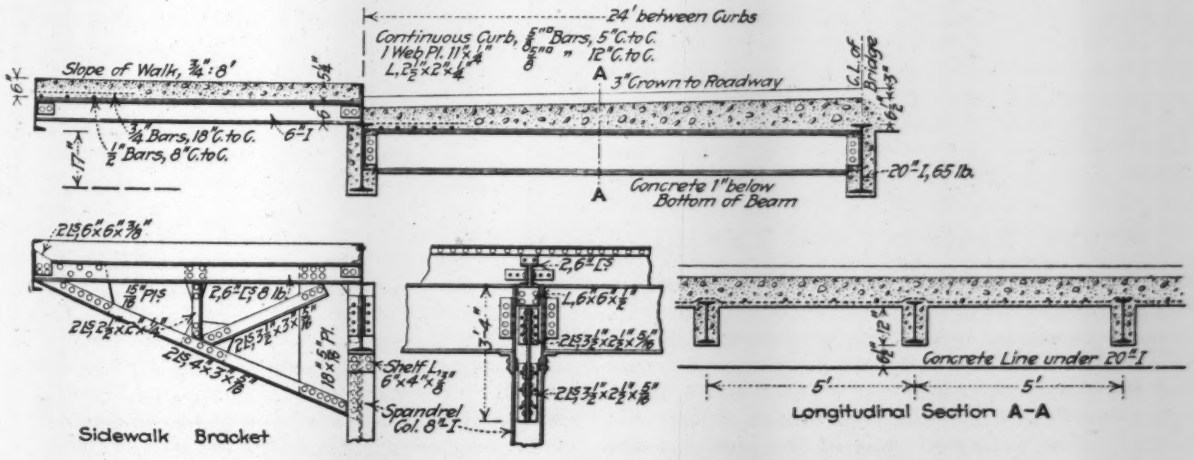


FIG. 4. FLOOR FRAMING OF WEST NEW YORK ST. BRIDGE AT INDIANAPOLIS, IND.

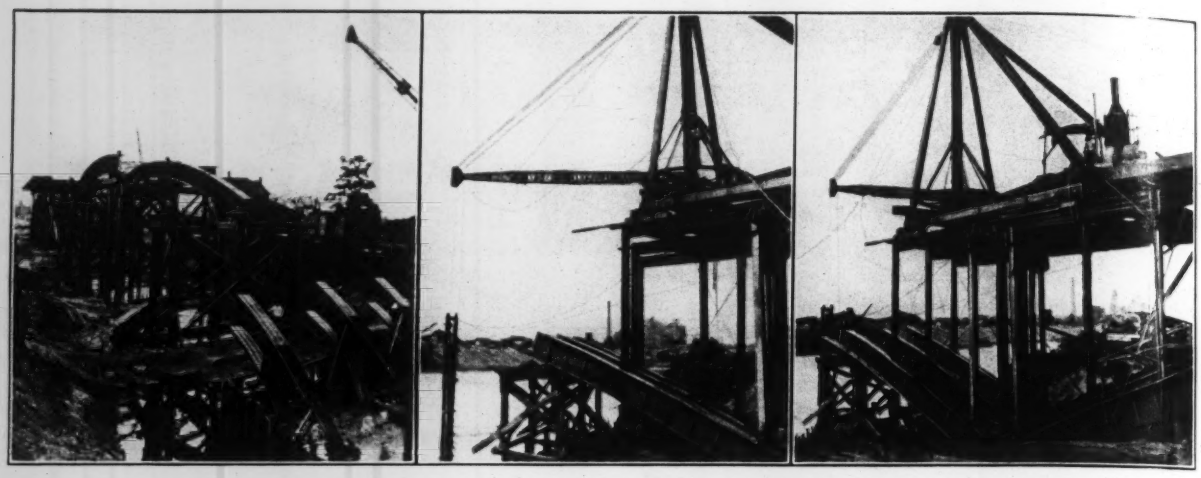


FIG. 5. CONSTRUCTION WORK ON THE STEEL ARCH BRIDGE AT INDIANAPOLIS

terforts on the inner side corresponding to the outside cantilever brackets for the sidewalk approaches.

The erection of the steel superstructure was commenced July 1 and completed (except for the hand railing) on Nov. 1, 1915. The two shore spans at the east end were erected by a traveler working parallel to, and on the north side of, the bridge. The ground on which this traveler moved was about 8 to 10 ft. above the springing line of the arches. Fig. 5 shows some of the stages of the construction work.

The traveler was placed upon the deck of the structure by means of the storage-yard derrick, located just north of the pier between the two shore spans. It then moved westward, driving piles for falsework by means of a steam hammer in leads slung from the boom. When all the falsework bents within reach were completed, the steel was erected upon them; and the traveler moved forward to drive piling and place steel for another section of the arch. For each span there were eight three-post bents, braced together in pairs to form four towers.

The traveler was an A-frame derrick of steel construction, moving on rollers and having a platform about 30x18 ft. The mast was 40 ft. high, and the box lattice boom was 75 ft. long. The machine complete weighed about 15 tons and was operated by a steam hoisting engine. The lifting capacity was 15 tons, and the heaviest loads handled weighed about 12 tons. This traveler was arranged to occupy about half the width of the floor, and on the other half was a material track for moving out the steel, which was loaded on push-cars by the derrick at the storage yard (along the north side of the two east spans).

The total weight of structural steel is about 830 tons. The exposed steel is given one finishing coat of black paint.

Heavy Rails on the Lehigh Valley Railroad

The new 136-lb. rail of the Lehigh Valley R.R. is the heaviest yet adopted in this country. The Central Railroad of New Jersey has had a 135-lb. rail for some time, and the Pennsylvania R.R. last year adopted a 125-lb. rail, as noted in *Engineering News*, Oct. 14, 1915.

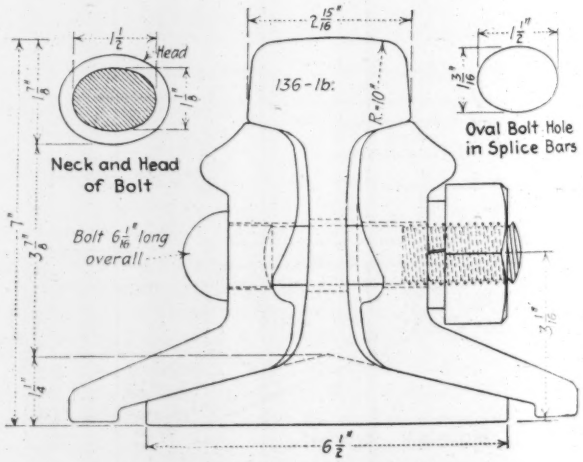
This new rail is designed especially for use on the mountain divisions having heavy grades and sharp curves. There is very little of it in service as yet. Its dimensions are given in Table 1. This road already had a 110-lb. rail for use under such conditions, where the wear of the rail head is exceptionally severe (*Engineering News*, Oct. 24, 1912). The new 136-lb. rail has the unusual height of 7 in. The older 110-lb. special section is of the same height as the standard 100-lb. section (6 in.), the

TABLE 1. DIMENSIONS OF HEAVY RAILS; LEHIGH VALLEY R.R.

	136 lb.	110 lb.
Weight per yd.		
Height	7 in.	6 in.
Width of base	6½ in.	5½ in.
Width of head, bottom	2 11/16 in.	2¼ in.
Side of head, slope	4°	4°
Depth of head	1 7/16 in.	1⅜ in.
Depth of web	3 7/16 in.	3 1/16 in.
Depth of base	1½ in.	1 1/16 in.
Thickness of web	½ in.	½ in.
Thickness, edge of base	7/16 in.	⅜ in.
Height to center of hole (and neutral axis)	3 7/16 in.	2¾ in.
Radius of:		
Head	10 in.	10 in.
Top corners of head	7/16 in.	7/16 in.
Bottom corners of head	¼ in.	¼ in.
Sides of web	14 in.	14 in.
Top fillets	½ in.	½ in.
Bottom fillets	¾ in.	¾ in.
Corners of base	7/16 in.	7/16 in.
Fishing angles (4 to 1)	13°	13°

TABLE 2. PROPORTIONS OF HEAVY RAILS

Railway	Lehigh Valley R.R.	Pennsylvania R.R.	Central Railroad of New Jersey
Weight	136 lb.	125 lb.	135 lb.
Height	7 in.	6¼ in.	6½ in.
Head	35.4%, 4.72 sq.in.	38.9%, 4.73 sq.in.	40.28%
Web	23.7%, 3.17 sq.in.	20.3%, 2.47 sq.in.	21.90%
Base	40.9%, 5.46 sq.in.	40.8%, 4.95 sq.in.	37.82½%
Total	100.0%, 13.35 sq.in.	100.0%, 12.15 sq.in.	100.00%
Moment of inertia	86.57	68.7	72.39



136-LB. RAIL; LEHIGH VALLEY R.R.

additional weight being given by a greater depth of head, which resulted in a correspondingly reduced depth of splice bar. The new rail has the same exceptional depth of head.

The distribution of area and weight in the 136-lb. rail, as compared with two other heavy rails, is given in Table 2. It will be seen that the proportion of metal in the head is lower in the heaviest rail. That is due mainly to the greater height, but the head of the 125-lb. rail is somewhat larger than that of the 136-lb. rail.

The joints of the 136-lb. rail are spliced with heavy angle bars, which are only 26 in. long, but have six bolts spaced 4 in. c. to c. The bolts are of unusual size—$1\frac{1}{16}$ in. in diameter—in the shank, and have rolled threads $1\frac{1}{8}$ in. in diameter. The neck and head are both oval, as shown. Square nuts and spring nut locks are used. As the bolts are placed alternately with head and nut on the inside of the rail, the bolt holes in the splice bars are alternately $1\frac{3}{16}$ in. in diameter and $1\frac{3}{16}$x$1\frac{1}{2}$ in. oval. The rails have bolt holes $1\frac{5}{16}$ in. in diameter.

For information we are indebted to E. B. Ashby, Chief Engineer, Lehigh Valley R.R.

Report of the Panama Canal Slide Commission

A brief summary of the report of the commission to study the Panama Canal slides, which was nominated by the National Academy of Sciences and appointed by President Wilson, Nov. 18, was printed on page 532 of the last issue. A more extended abstract of the report follows:

The total amount of material excavated and remaining to be excavated from the slides on the Panama Canal in the Gaillard Cut is in round figures about 50,000,000 cu.yd. It is of interest to mention that this is more than half as great as the yardage which was estimated by the Board of Engineers of 1906 as the total excavation required for the Panama Canal work. At that time also the total estimated excavation for the Gaillard Cut was less than 54,000,000 cu.yd., but this amount was afterward increased by enlargement of the cross-section.

The three great slides on the canal are, first, the Cucaracha slide, which has been in progress since the days when the work under De Lesseps was active in the early 80's. Nearly 10,000,000 cu.yd. had been excavated from this slide by Dec. 30, 1915. It is located immediately south of the traprock dike known as Gold Hill, the top of which is about 600 ft. above the level. North of Gold Hill is the East Culebra slide, which began on Oct. 14, 1914; and from this slide 14,687,000 cu.yd. had been excavated to Dec. 30. The third great slide is the West Culebra slide, immediately opposite the East Culebra slide, from which about 11,000,000 cu.yd. had been excavated to Dec. 30.

From all the other slides on the sides of the Gaillard Cut the total excavation was only 4,852,000 cu.yd. to Dec. 30. The total yardage remaining to be excavated in the three great slides on Dec. 30 was 9,600,000 cu.yd.; and from all other slides combined, only 330,000 cu.yd.

Answering the question whether the great slides will extend their limits and cause further serious trouble, the commission believes that no great extension of these slides is probable, because the soft rock that constitutes a very large part of the slide is quite limited in extent. The commission thinks it possible, however, that a large mass of soft rock between the West Culebra slide and Contractor's Hill may finally be set in motion. The mass involved, however, will be small compared with that of the West Culebra slide.

The most serious possibility in connection with the sliding ground at Panama is that the high hills along the deepest part of the Gaillard Cut may move toward the canal. The commission says that these hills, so far as it can determine, are composed of intrusive bodies of basalt or masses of the hard Obispo tuff. So far as can be judged, the hard rock masses which form these hills extend far into the earth and are self-supporting. Rock may slough off from them, but there is no evidence that they will collapse.

It should be understood that the great bulk of the sliding material at Panama is not earth, but weak rock. Most of this rock is of the stratified Cucaracha formation. These beds occur only in the Culebra district, but have a thickness in places of over 400 ft. The soft, slippery nature of the materials of which this rock is composed and their loose, unconsolidated condition make it very weak. Faults and joint planes in the rock are also partly responsible for the slides.

The commission finds no evidence that earthquake shocks have had any material effect in producing slides. It does believe, however, that the heavy rainfall has an important influence. The average annual rainfall in the Culebra district is about 85 in. per annum, concentrated in eight months of the year. Notwithstanding the ill-success of the French company in preventing slides by surface drainage, the commission believes that every available device should be used to keep water away from the slides.

The commission suggests that the deep cracks which form in the earth adjacent to the slides during the dry season as the ground shrinks should be systematically filled, in order that surface water may not be led into them. The commission also suggests drainage by tunnels driven underneath sliding ground in undisturbed material, but says the plan should be tried with caution. It is further proposed that a cut be made by sluicing with a hydraulic jet in the East Culebra slide, extending from the canal back to a large pond that now exists on the slide. A somewhat similar cut should be made in the West Culebra slide. Through these cuts material could be sluiced down into the canal.

To assist in determining the likelihood of future slides, the commission recommends a careful system of surveys to detect incipient movements of the ground and deep core borings on each side of the canal with a drill giving large cores. A study is recommended of underground water and related data, to show the water table for different localities in the Culebra district and the effect of water on the underground strata, and of the chemical changes which cause the so-called hot areas that have been found in the canal rock, with tests to determine the strength of the rock in which slides have occurred.

In conclusion the commission says that, while it realizes that slides may be a considerable maintenance charge upon the canal for a number of years and that possibly trouble in the Culebra district may perhaps again close the canal, it believes that, after the present slides have been removed, navigation through the canal is not likely again to be seriously interrupted.

Chicago Track-Elevation Bridges of Illinois Central R.R.

SYNOPSIS—Two types of bridges are being used on the track-elevation work of the Illinois Central R.R. at Chicago. One has concrete bents supporting concrete deck slabs. The other has steel bents and girders supporting a deck of I-beams with concrete filling, and all steelwork is incased in concrete. This article describes the design and construction methods of both types of bridges.

Track elevation on the Illinois Central R.R. at Chicago is now in progress between 78th St. and Kensington Ave. In this outlying section of the city, which is not built up continuously, the railway is not required to build a subway at every street. The ordinance specifies subways for certain streets and provides that in the future the city may require others, in which case the work is to be done by the railway, but paid for by the city.

The bridges for nearly all the subways have supporting bents at the curb lines and in the middle of the roadway. Where a sewer exists, this construction necessitates diverting it to one side of the foundations of the central bent. The type of superstructure used most extensively has bents of concrete columns and girders carrying a deck of concrete slabs. Where clearance conditions make it necessary to employ a floor of minimum thickness, the bents have steel columns and cross-girders carrying a deck of I-beams, with concrete filled between them. All the steel is incased with concrete or cement mortar.

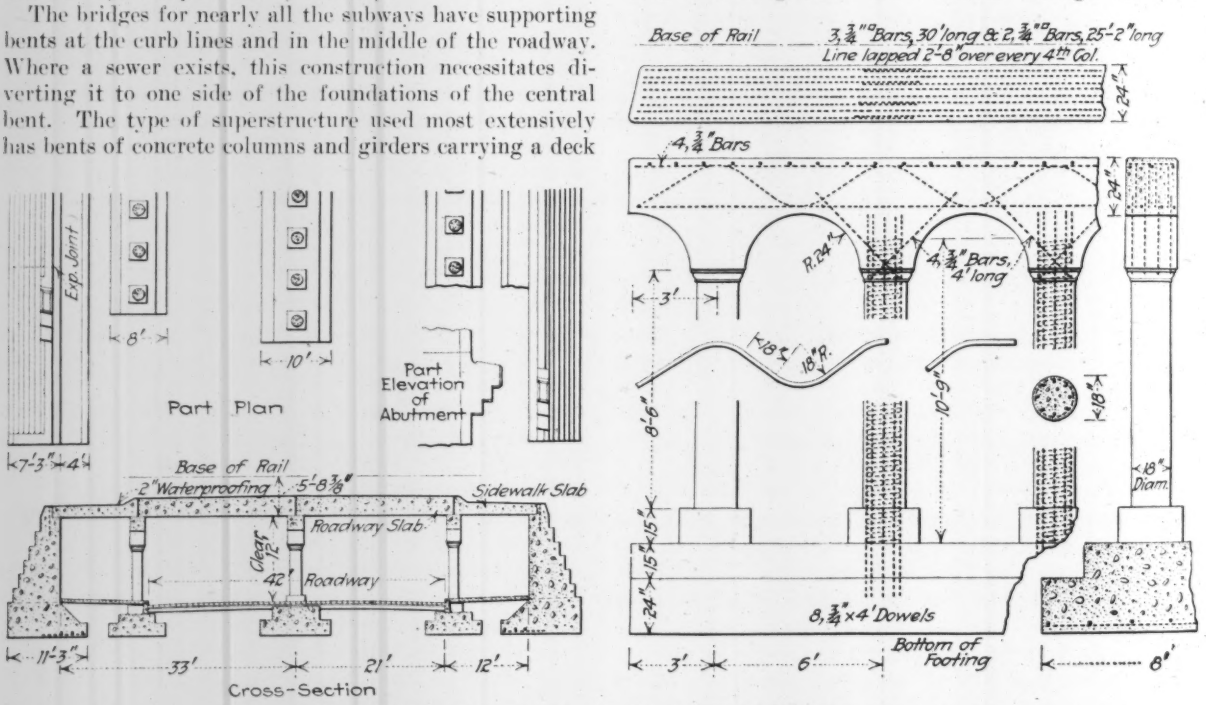


FIG. 1. CONCRETE BRIDGE ON TRACK ELEVATION; ILLINOIS CENTRAL R.R.

Concrete Subway Bridges

The typical design of the concrete structures is shown in Fig. 1. There are three bents spaced 22 ft. 3 in. c. to c. and 10 ft. 9 in. from the faces of the abutments. Each bent has a broad footing wall built directly upon the stiff clay, no piles being used. The clearance is 12 ft. where there are no street-car lines. Upon each footing is a row of cylindrical columns spaced 6 ft. c. to c., with square bases. They are connected by arches and support a cap girder. The columns, arches and girders are of monolithic construction, and no expansion joints are provided. The middle bent has 21-in. columns and a cap girder 27 in. wide and 24 in. deep. The side bents have 18-in. columns and girders 24 in. square.

The reinforcement in each column consists of eight vertical rods and a wire spiral of 2-in. pitch, having two spacing bars to maintain the pitch while the concrete is being poured. The rods extend into the footings. The column bases have horizontal rectangular hoops. The girders have longitudinal rods in the top and bottom, with short cross-rods in the top. There are no stirrups, and none of the horizontal rods are bent up. Instead, there are wavy longitudinal shear bars, as shown. They have a depth of 18 in. and a pitch of 6 ft. for the waves, the radius of which is 18 in. In addition, there are diagonal rods extending from the columns through the knee-brace arches into the girder. All bars are of the deformed type, of square section.

The abutments are of mass concrete, with expansion joints about 25 ft. apart. The footing has a long toe extending under the sidewalk. The rough ends of the parapet slabs at each side of the bridge are masked by parapets of similar shape, built up on the bridge seats. Along the back of each abutment is a 6-in. tile drain, sloping on a grade of 1%.

The columns and girders are cast in Blaw steel forms, which are owned by the railway and furnished to the contractor. They give a smooth, dense surface finish. The wooden forms used for the remainder of the work had the tie-rods placed within tin tubes. When the forms were

removed, the rods were pulled out, the tubes clipped off and the ends of the holes filled with cement mortar.

The concrete is a 1:3:6 mixture for the footing walls, 1:2:4 for the bases of the columns and 1:1½:3 for the columns and girders. The coarse aggregate is screened limestone, not exceeding 2 in. in size for the footings. For the columns and girders the size is about ⅜ in., as the restricted space and the amount of reinforcing steel make it necessary to use a slushy mixture that will fill all voids. The only tamping that can be done is to stir the mass with long sticks of wood. In the abutments the concrete is 1:3:6 for the footing, 1:2½:5 for the main portion (faced) and 1:2:4 for the bridge seats.

The amount of concrete for the three bents is 355 cu.yd. in the footings and column bases and 115 cu.yd. in the columns and girders, or 470 cu.yd. in all. The two abutments require about 1,300 cu.yd., making a total of 1,770 cu.yd. exclusive of the deck.

The concreting of the abutments and bents was done from the contractor's train stationed on a running track given up temporarily for this purpose—usually one of the tracks on the west side. The train was made up of three cars, one being a flat-car with drum mixer.

Most of the concrete was spouted through the deck of the trestle into a hopper, from which it was discharged into wheeled carts and distributed to the forms. For some parts the concrete was spouted directly by means of a chute extending across the adjacent running track. The plan was not used extensively, as it necessitated great care and watchfulness to keep the spout clear of trains.

Concrete Slabs for Subway Deck

The decks of the concrete subways consist of rows of reinforced-concrete slabs spanning the sidewalks and the roadway. The construction of these slabs is shown in Fig. 2. The slabs for the roadway spans are 22 ft. 7⅜ in. long and 6 ft. 5¾ in. wide. Their ends are at an angle of 79° with the sides, owing to the skew of the bridge. The thickness is 34 in. for about 6½ ft. at one end (over the middle bent), and the top then has a slope for drainage to the other end, where the thickness is 31¾ in. At each end is a lifting stirrup made of a 2-in. square bar. Its loop is in a pocket that is filled with cement mortar after the slab is in place. The slabs for the sidewalk spans are about 12x4 ft. They are 31¾ in. thick where they abut against the larger slabs on the bents, and the thickness is reduced to 18 in. at the abutment end.

Special slabs are used to form the parapets along each side of the bridge. They are of L-shape, 6 ft. 3 in. high and 4 ft. wide, with the exterior surfaces relieved by recessed panels, which are cast in place in well-oiled wood forms. No surface-finishing treatment is given. In each parapet slab is embedded a ½-in. electric conduit for wires to the lamps in the roof of the subway.

The tracks cross the streets on the skew, and the slabs are parallel with the tracks, so that they are all of irregular form, as shown by the plan, Fig. 3. This arrangement was adopted for convenience in construction. With one or two tracks closed temporarily, all the slabs for this part of the deck could be placed. If the slabs had been square with the abutments, the tracks would have crossed them diagonally and the placing would have been more troublesome.

The main and parapet slabs of the roadway spans contain about 15 and 11.7 cu.yd. of concrete and weigh about 30 and 23.4 tons respectively. The main and parapet slabs of the sidewalk spans contain 4.9 and 5.6 cu.yd. and weigh about 9.8 and 11.2 tons respectively.

Making the Concrete Slabs

The deck slabs (with the exception of the parapets) were made in a yard near 100th St., having two casting platforms separated by a pair of tracks. On one track ran a traveling mixer plant, the bins of which were kept supplied by a locomotive crane (with grab bucket) running on the other track. The concrete was spouted directly into the forms, which were lined with sheet steel.

About 340 slabs were made, and each was marked with a number and the date of pouring. The largest were 25

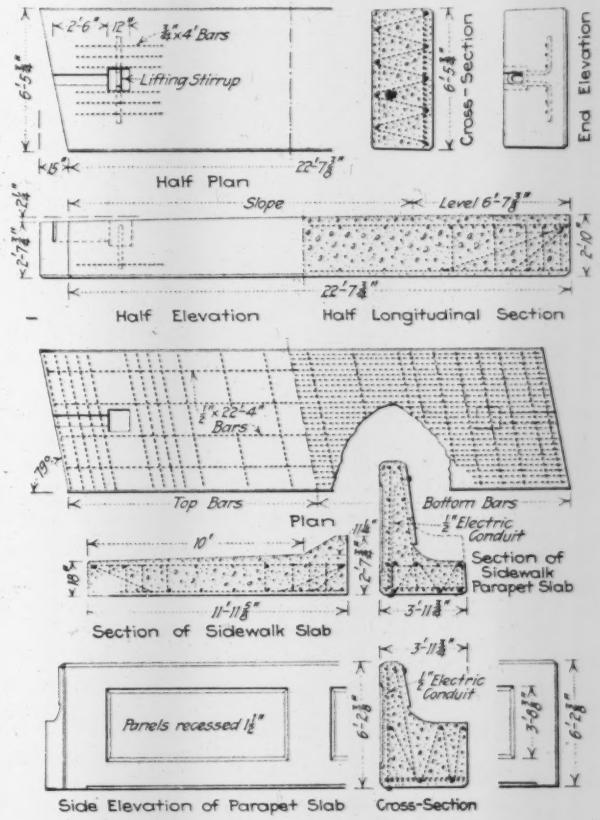


FIG. 2. CONCRETE SLAB FOR DECK OF BRIDGE

ft. in length and weighed about 35 tons. They were stacked in the yard until required, being held for 21 days, and no slab was allowed to have any load upon it until it was at least 60 days old. A railway wrecking crane or derrick-car loaded the slabs upon flat-cars, upon which they were hauled to the site, where the same crane or derrick set them in position.

The concrete is a 1:2:4 mix, using stone of not over 2-in. size. The reinforcement consists of longitudinal and transverse bars at top and bottom, some of the latter being bent up at the ends. There are also transverse stirrups at each end, and short distributing bars are laid across the feet of the lifting stirrups.

As already explained, steel construction is employed where limitations of clearance necessitate a floor of minimum thickness. The 79th St. subway, shown in Fig. 4, is typical of such subways. Here the Illinois Central R.R. crosses above the street and beneath the New York, Chi-

cago & St. Louis R.R., and the foundations include supports for the bridge of the latter road. The subway is 200 ft. long, with a width of 80 ft., except that at one end there is an additional span for the station approach, making a width of 103 ft.

There are three bents (four at the widest part), composed of steel columns spaced 14 ft. 6 in. c. to c., with cross-girders framed between them and resting on large triangular knee-brace brackets. The columns are composed mainly of pairs of 12-in. channels (flanged inward), with a plate 12x½ in. secured to their webs by four angles 4x4 in. Three of the columns support the columns of the railway bridge over the tracks. One is similar to the ordinary columns, but with 15-in. channels. The others are of specially heavy construction, owing to the concentration of loads. The girders are 48½ in. deep.

The columns and girders are incased in 1:2 cement mortar. The forms for this filling had wooden stops on the inside, to bear against the steel and insure the proper position, as the space was too restricted to permit sufficient interior inspection to see that the forms were adjusted exactly. After the forms had been removed, these stops were bored out with an auger and the holes filled with mortar.

The deck consists of I-beams parallel with the tracks. The roadway spans have 20-in. I-beams spaced 13 per panel. The sidewalk spans have 15-in. I-beams spaced 15 per panel. Concrete is filled between the beams and to a depth of 2 in. below the flanges, which are wrapped with wire netting. In the concrete are embedded wooden blocks for the trolley-wire attachments. The concrete is flush with the tops of the I-beams, and the entire floor is covered with a 2-in. bituminous waterproofing course. Drainage is provided by sloping the floor slightly to one end. The maximum thickness of this floor, including waterproofing, is only 24 in. At each side of the floor is a low parapet wall of reinforced concrete.

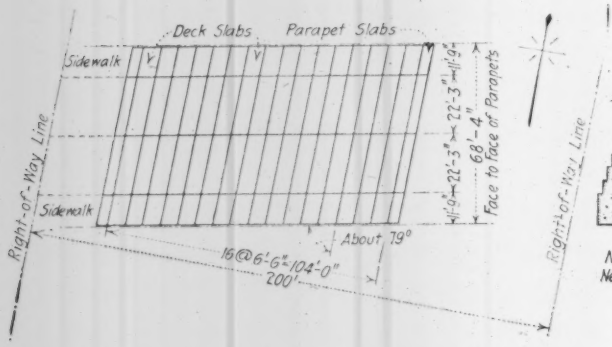


FIG. 3. PLAN SHOWING ARRANGEMENT OF DECK SLABS OF BRIDGE

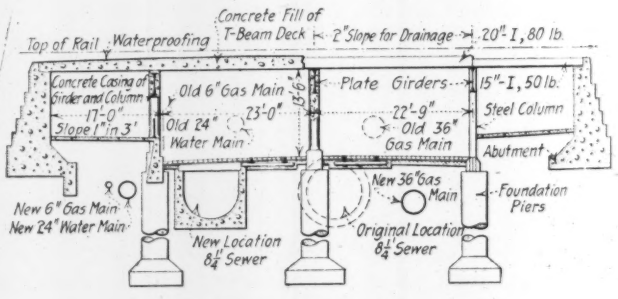


FIG. 4. STEEL SUBWAY BRIDGE FOR TRACK ELEVATION; ILLINOIS CENTRAL R.R.

Each column rests on a 5-ft. concrete pier sunk to hardpan at an average depth of 40 ft. Open wells were excavated in the manner common for Chicago's foundation piers and then filled with concrete. There are 51 of these 5-ft. piers and three larger piers for the columns that support upper columns for the railway bridge crossing the Illinois Central R.R. The abutments rest upon the clay, and no piles are used.

The track-elevation work was originally planned to cross above the Nickel Plate Ry. at 79th St., and the line has an ascending grade. When it was decided to pass under the other road, the grade had to be lowered, and the lowering at 79th St. was about 11 ft. For the subway it was necessary to depress the street about 10 ft. (more than is usually the case), in order to give a clearance of 13 ft. 6 in. required for streets having car tracks. The sidewalks are depressed only enough to give a clearance of 9½ ft., thus avoiding unnecessarily steep grades for the approaches and also saving in excavation and abutment masonry.

A six-track trestle was first built, and then the street was excavated by hand. The material was removed in small steel dump-cars that were pushed to an elevator tower at one end of the subway and there dumped into a bucket, which in turn emptied the material into a railway car standing on the trestle. The next step was to sink the foundation wells and build the foundation piers. An 8¼-ft. sewer had to be diverted to make way for the foundation of the central bent. A concrete box sewer was built under one roadway; and when this sewer was ready for use, the sewage flow was diverted into and out of it by wooden flumes while the connections to the sewer were being built.

In lowering the grade of the railway the steam shovel made a through cut for each track in turn, beginning at the east side. The tracks were thus lowered one by one. In placing the steel for the subway, work began at the west side and progressed across the tracks to the east. In placing the concrete deck, the work began at the east side, and successive strips were poured, each about 13 ft. wide (for one track). By working in this way the closing of tracks to traffic was reduced to a minimum.

The strip of concrete deck was dry enough in 24 hr. to receive the waterproof covering, the placing of which took about another day. The deck was then left for seven days before track was laid or any load put upon it. The concrete for the abutments and the concrete filling of the deck were made in a mixing plant at one corner of the work and distributed from an elevator tower. The concrete was either spouted directly into place or spouted to a hopper, from which wheeled carts were loaded.

The contractor for the erection of the steel removed the caps and stringers of the temporary trestle, using his locomotive crane. Where this preliminary work is done by the railway company, it must use its own derrick-car, which is then in the way and interferes with other work in an already congested space. For this reason the Illinois Central and some other railways now require contractors to remove this part of the temporary work.

As the tracks do not occupy the full width of the right-of-way, retaining walls are not required. A sand-fill is built for the necessary width, and the slopes are blanketed with cinders as a protection against the wind. The filling is done by the railway forces, using side-door gondola-cars and unloading plows. At present there are six main tracks—two each for suburban, through-passenger and freight trains. There are also industry and yard connections. The traffic is heavy, and there are numerous freight-transfer movements.

The tracks temporarily come down to the street level near 95th St., where there is a grade crossing with the Rock Island lines. When these grades are separated, the street will be lowered about 8 ft. and the Illinois Central R.R. will be elevated about 4 ft. This is the third combined railway and street-grade crossing within a short distance. At 75th St. and 70th St. the Illinois Central R.R. tracks have been raised and the other lines raised still higher to cross over them. At these points the streets are depressed more than usual, so as to avoid an excessive elevation for the double-deck crossing (*Engineering News*, Nov. 4, 1915).

Engineers and Contractors

The work is under the direction of A. S. Baldwin, Chief Engineer, and F. L. Thompson, Assistant Chief Engineer. The engineer in charge of the work is M. D. Thompson. The railway company's forces built all temporary trestles, did the filling, handled and placed the concrete deck slabs, laid all the waterproofing and did all shifting and laying of tracks.

The excavation for lowering the tracks was done by J. D. Lynch & Co. The concrete work was divided between the Bates & Rogers Construction Co., the J. O. Heyworth Co. and the John J. O'Heron Co. The precast slabs were made by the C. F. Massey Co. The Ketler-Elliott Construction Co. and the Strobel Steel Construction Co. were contractors for the steelwork. Most of the street and sewer work and excavation was done by the Contracting Material Co.

The street-railway company built its own tracks, and water and gas mains were shifted by the city forces and the gas company.

Operations commenced in June, 1915. The concrete work was finished in November, and the placing of the slab decks was completed by the end of the year.

New Gravity Water-Supply for Aberdeen, Wash.

Contributed

The gravity water-supply system for Aberdeen, Wash., about to be built at a cost of $400,000, has some interesting comparative features.

The original report as to the desirability of bringing the water from the Wishkah River instead of from the Wynooche River was made to the city in June, 1915, by R. H. Thomson, consulting engineer, Seattle. The great cost of the line from the Wynooche, the larger of the two rivers, combined with greater difficulties to be encountered in the construction, rendered it advisable to consider only the possible routes from the Wishkah River and the means by which water from the Wynooche could be diverted across to the Wishkah whenever a greater future supply should become necessary.

The preliminary surveys from the Wishkah were completed by L. D. Kelsey, city engineer, last January. In a review of the two possible routes, one on a private right-of-way—line "A"—and one on a free right-of-way along the county road for a greater portion of the distance—line "B"—Mr. Thomson reported in favor of line "A," thus corroborating the findings made by Mr. Kelsey.

The attractions of route "B," due to free right-of-way and ease of access for construction along the county road, led to some discussion in council, and J. L. Stannard, consulting engineer, Portland, Ore., was called in to review the whole situation. His report, dated Feb. 29, 1916, corroborates the findings of Thomson and Kelsey in favor of route "A." This decision is due to the somewhat greater length of pipe line "B"; the greater head on the pipe by this route, requiring an additional cost of $76,000 in the one item of bands for the wood pipe; the greater cost and difficulty of laying the pipe in the side hill or bluffs along the road; and the extra cost of maintenance and of interruption to the supply in the case of slides or of flooding the line along the county road in rainy seasons.

WISHKAH RIVER DAM SITE. ABERDEEN WATER-SUPPLY

The total cost of the system on line "A," as shown by Stannard's report, is $392,835, while by line "B" the cost was found to be $485,815. The itemized cost of the pipe line alone is as follows:

	"A" Line	"B" Lline
Lumber, $31.50 per M.	$82,864	$87,686
Bands and shoes, $3.50 per 100 lb.	76,400	152,390
Excavation and backfill	86,020	89,070
Clearing and grubbing	18,900	8,600

The pipe for line "A" would be 28 in. and for line "B" 32 in. in diameter. The diversion dam in each case would be of timber crib construction, 25 ft. high for project "A" and 55 ft. for project "B."

The possible low water-supply from the Wishkah, as found by the city engineer, is 9,500,000 gal. in 24 hr., or 0.9 cu.ft. per sec. per sq.mi. of drainage area. The Santiam River in the Willamette basin (Oregon) shows a runoff of 1.5 cu.ft. per sec. per sq.mi., and the Cedar River basin (Seattle) 0.9 cu.ft.

The city council of Aberdeen has ordered construction commenced on route "A," and contracts for lumber, bands and shoes are to be made at once. Actual construction will be proceeded with as soon as the location is made in the field.

L. D. Kelsey, city engineer, is to have charge of construction, with R. H. Thomson, Seattle, consulting engineer.

Unique Method Used To Build Rock-Fill Dam

By George W. Howson*

SYNOPSIS—Rock-fill dam of the Sierra & San Francisco Power Co., near Sonora, Calif. Exceptional features in design and method of construction. Section has three types of fill—quarry rock dropped from cableway; shaped rock laid on face; reinforced-concrete water-tight facing. Stone brought from eight quarries; from seven of these on cableways, each starting from a quarry and all centering at a movable suspended plate over the dam.

On the development of the South and Middle Forks of the Stanislaus River the Sierra & San Francisco Power Co. will shortly complete the construction of its second large storage reservoir. This development includes the construction of five storage dams, approximately 20 mi. of conduit, two high-head power plants and transmission lines, both primary and secondary.

*Chief Engineer, Sierra & San Francisco Power Co., San Francisco, Calif.

Under the progressive program of development being carried out one storage dam, one hydro-electric installation of 40,000 hp., 135 mi. of primary transmission line, with secondary transmission and distribution lines covering a large part of central California, have been completed, while the second large storage reservoir formed by Strawberry dam is nearing completion. The storage reservoirs are all above the 5,000-ft. contour, and this location, together with the natural flow, forms the ultimate source for the complete development of the two rivers. A steam stand-by station of 24,000 hp., located in San Francisco, insures continuous service.

This article covers some of the interesting features in connection with the construction and design of Strawberry dam, which impounds the second of the five storage reservoirs contemplated. This dam is located on the South Fork of the Stanislaus River, in Tuolumne County, California, 32 mi. northeast of the town of Sonora. The work is 19 mi. from a railroad, so that a long haul over mountain roads is required for all equipment, supplies and material. This long haul, together with the character

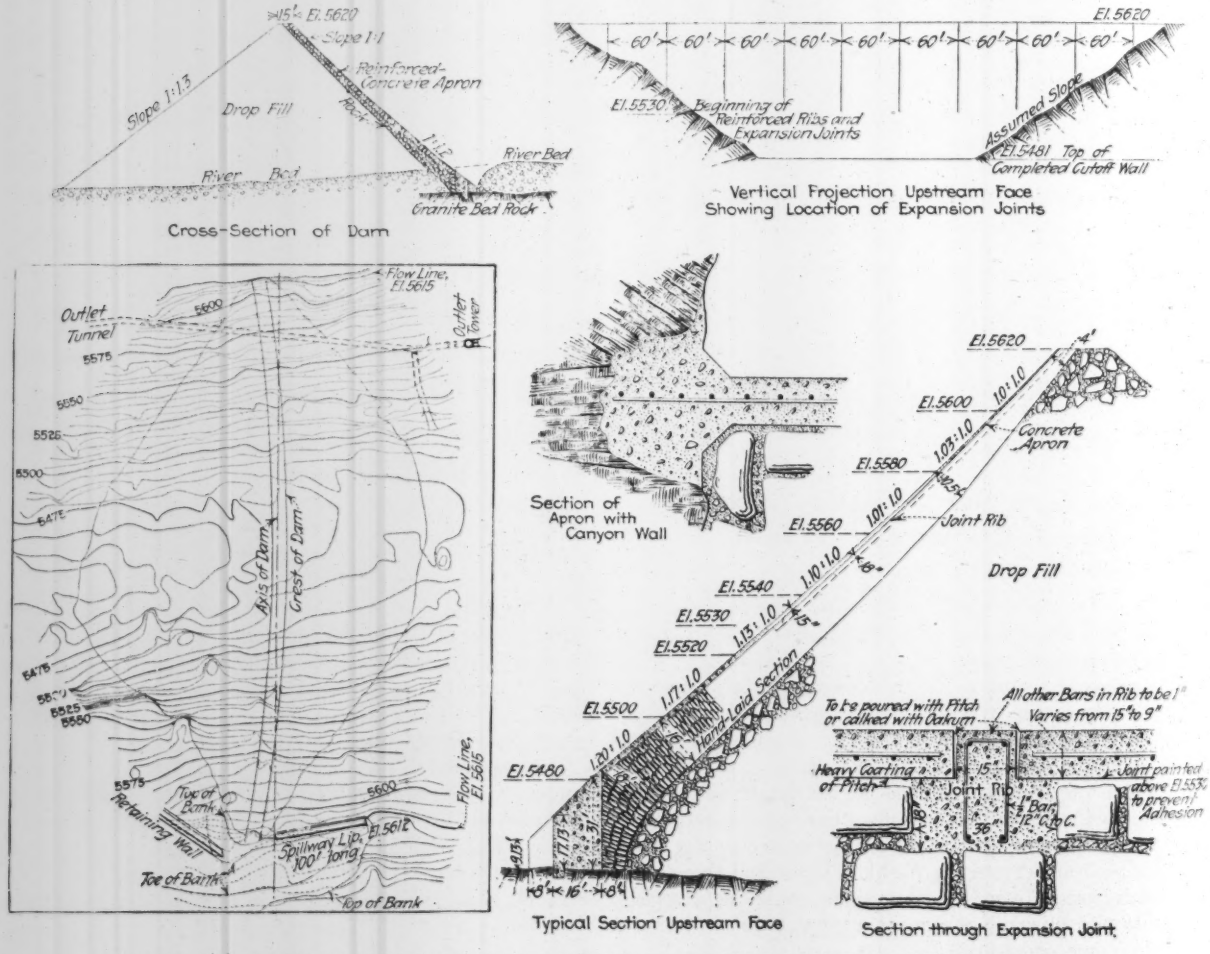


FIG. 1. GENERAL LAYOUT AND DETAILS OF STRAWBERRY DAM, NEAR SONORA, CALIF.

FIG. 2. UPSTREAM FACE OF STRAWBERRY DAM DURING PLACING OF FACE CONCRETE

of the foundation and excellent opportunity for quarrying rock, assisted in determining on a rock-fill type of dam.

The new dam replaces a log-crib dam built in 1861, to supply water to the Southern Mines along the Mother Lode. This reservoir has been in continuous service since constructed. The timbers forming the cribs in the interior of the structure were found to be sound and firm after 55 years' service.

Elements of the Dam Design

The dam is of that class of rock-fill structures in which the drop-fill supports the laid section under all conditions, as compared to the other class in which the laid wall assists in supporting the drop-fill under the condition of reservoir empty.

The dam is arched in an upstream direction, having a 20-ft. ordinate at the center. It is not expected that there will be an added factor of stability due to arch action in the drop-fill, but that any movement due to settlement will shorten the arch length and tend to close possible cracks in the apron. The slope of the upstream face gradually merges from 1 on 1.2 at the river bed to 1 on 1 at the crest, thus presenting a concave face to the water surface. These two curves in the general structure make the survey work arduous, but offer no difficulty from the construction point of view.

All earth and perishable material were removed from within the area of the foundation of the dam down to rock on the cañon walls and down to the level of the river bed across the floor of the cañon. At the level of the river

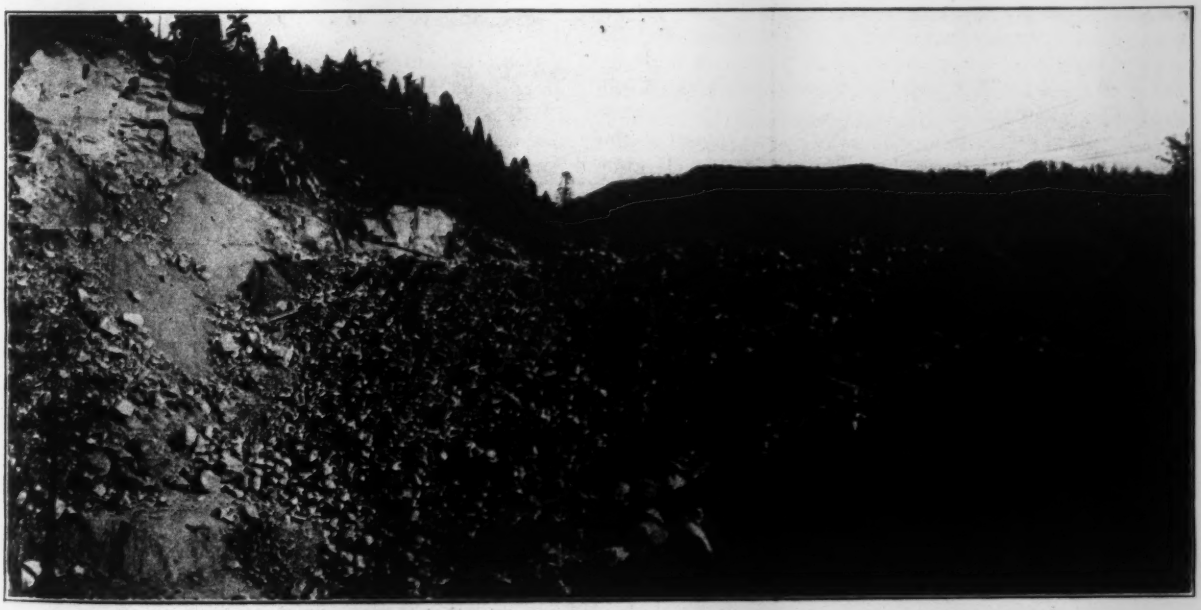


FIG. 3. EARLY STAGE IN DEPOSITION OF ROCK-FILL IN STRAWBERRY DAM

a cemented gravel, not subject to wash, was encountered. The drop-fill of the dam was built directly upon this foundation. A great many thousand cubic yards of material was excavated in preparing the foundation, all excavation across the floor of the cañon being made by steam shovel and cars, while a hydraulic giant cleared the cañon walls.

The concrete apron forming the water-tight skin on the upstream face of the dam terminates at the bottom in a concrete toe wall, which was carried down through the cemented gravel into bedrock 33 ft. below the river bed. This excavation and the concrete work were done during the low-water season of 1914, while the river could be controlled in a flume spanning the excavation. The derrick-laid section was also carried down to bedrock.

The drop-fill section of the dam was made by dropping the rock from 20 to 70 ft. from a cable system described later. This drop hammered and compacted the mass and, it is expected, will greatly reduce the amount of settlement in the completed structure. The derrick-laid section is carried back and built against the compacted and undisturbed drop-fill, thus insuring a solid, firm backing for the laid section that must support the concrete apron and water load.

The concrete apron is cast monolithic from the toe wall up for one-third the height of the dam and from cañon wall to cañon wall. The upper two-thirds of the apron is designed with vertical expansion joints spaced 60 ft. These joints butt up against and are supported by concrete ribs built into the laid section. Between these expansion joints the apron is free to slide upon a smooth plastered surface. It is expected that this sliding plane will prevent cracks in the apron due to temperature stresses or to settlement in the dam structure. The entire apron is heavily reinforced, as shown in Fig. 1.

Water is drawn from the reservoir through an outlet tunnel 600 ft. long cut through solid rock at one end of the dam. An outlet tower at the upper end of the tunnel, with six 30-in. sluice gates radially spaced at various elevations, will control the water entering the tunnel, while more refined regulation by needle valves will be possible at the discharge end. This duplicate regulation is an insurance against the loss of water, and the refined regulation is very desirable on account of the large value of the water for power purposes through the 3,300-ft.-head available.

The spillway is cut through solid rock adjacent to one end of the dam. The spillway lip is 8 ft. in elevation below the crest of the dam and has a length of 100 ft.

Seven Quarry Cableways Center Above Dam

The rock for the structure is being obtained from eight quarries, one operated with a steam shovel and construction trains, while the rock from the other seven quarries is transported by cableways. An original method of transporting and delivering the rock to the fill was developed on this work—namely, having a system of cables all radiating from a central steel plate suspended over the fill to secure anchors back on the hillside above the quarries. Each cable performs the double function of being the carrying cable from its particular quarry and of acting as a guy line for the remainder of the system. The center steel plate, called the spider (from the similarity of the system to a spider web), is always maintained as the lowest point of the system.

The rock from each quarry is delivered to the fill by a single-line hoisting engine, which hoists the load from the quarry pit to the carrying cable, where a mechanical device engages the carriage and the load runs out over the fill by gravity. The load is discharged automatically at a bumper, after which the carriage is again drawn back by the single-line hoist until it again strikes the mechanical device over the quarry pit, which automatically trips and allows the line to lower to the quarry. The round trip requires about 2 min., while the maximum distance of delivery is approximately 800 ft. Loads of 5 tons were readily handled on 1¼-in. cables.

The entire system is very flexible, as the central plate is readily moved to different points of the fill by taking in and letting out on the proper cables, and the position of the bumper on any individual line is quickly changed. This method of transporting and placing material is the fastest and most economical that has come to the author's attention and is the outgrowth of much study and experimenting in connection with making the large fill at the Strawberry dam.

All rocks in the laid section are handled by derricks. One of the striking features is the quality of this work. Face rocks are selected stones, carefully set to line, a variation of 3 in. from the theoretical line being allowed. These rocks vary from 2 to 5 tons and are all well supported and wedged tightly in place.

The dam is being built for the Sierra & San Francisco Power Co. by Chadwick & Sykes, general contractors. H. L. Livingston is superintendent for the contractors and J. S. Malony for the power company. F. I. Doane is assistant engineer. Ford, Bacon & Davis, New York City, who are engineers for the power company, prepared the plans and estimates. The work is being carried out under the direction of H. F. Jackson, Vice-President and General Manager of the power company, under the immediate supervision of the author, in general charge of the extensions of the power company's hydro-electric developments. M. M. O'Shaughnessy was consulting engineer.

Gen. William Sooy Smith

Gen. William Sooy Smith, who died of pneumonia on Mar. 4, at Medford, Ore., where he had resided since 1910, was in his eighty-fifth year and was one of the very few men still surviving who were prominent in American engineering work prior to the Civil War.

He was born of Quaker parentage at Tarleton, Ohio, July 22, 1830. He worked his way through Ohio University, graduating in 1849. He at once entered West Point and graduated sixth in the class of 1853. His military title was won later, however, for he soon resigned from the army to engage in civil-engineering work. In this field he displayed the originality and resource that made him widely known in the profession.

In 1869, as engineer for the New Jersey Steel and Iron Co., he built a bridge for the Charleston & Savannah R.R. across the Savannah River. The pier foundations were being sunk by the pneumatic process, which had just been introduced into this country from France; and the design of the apparatus as copied from the French practice was crude and ineffective. All the material excavated had to be hoisted in bags and handled through a small air lock. Smith built a much larger lock, in

which a considerable amount of material could be accumulated and hoisted out in bulk. He then developed the plan, which has ever since been used, of blowing out the loose material by permitting the air to escape through a pipe.

The origin of this latter process was as follows: One of the cylinders in process of sinking reached a stratum so impermeable that the air pressure did not force out the water inside the cylinder. A pipe was therefore run down through the air lock to the bottom of the caisson, so that the air pressure would force up the water through this pipe. When the pipe reached the sand bottom, it was found that the sand as well as the water was rapidly being driven out through it. A telescopic section was therefore put on the bottom of the pipe, and four laborers were put to work shoveling sand to the bottom of it, to keep it buried. According to Gen. Sooy Smith, on this piece of work this method of removing material from the caisson made it possible to excavate the material 24 times as fast as before.

It was while this work was in progress that the outbreak of the Civil War put a stop to civil-engineering work for a time. Gen. Sooy Smith at once returned to Ohio and enlisted in the volunteer army, being commissioned lieutenant-colonel and assistant adjutant-general. At the expiration of the three months' enlistment period, when the Ohio regiments were reorganized for three-year service, he was made colonel of the 13th Ohio Infantry. He served in the campaigns in West Virginia and was then transferred with his regiment to the Army of the Ohio. He was made brigadier-general for his service at the battle of Shiloh and was later on the staff of Grant and of Sherman; under the latter he was chief of cavalry of the Mississippi Division.

In 1864 a serious attack of rheumatism compelled his resignation from the army. After his restoration to health he again engaged in civil-engineering work, devoting himself largely to railway-bridge construction, especially in connection with the development of the pneumatic process. In 1876 he made designs for a double-track railway tunnel under the Detroit River. He proposed to build it by sinking a continuous series of pneumatic caissons across the river. His plan received the approval of a board of prominent engineers appointed to consider it; but the suggestion was in advance of the times, and it remained for the engineers of a later generation to carry out the plan in modified form.

When the manufacture of steel as a structural material began, he was one of the first to advocate the use of steel instead of iron as a bridge material. President Blackstone, of the Chicago & Alton R.R., appointed Gen. Sooy Smith chief engineer of the bridge over the Missouri River at Glasgow, Mo., and it was decided that the trusses should be made exclusively of steel. At that time the great weight of opinion among engineers was against the use of steel for bridges, on account of its variability and erratic behavior when subjected to shock and vibration, and this bridge was the first large all-steel truss bridge built in the world.

Soon after, Gen. Sooy Smith was chairman of a committee appointed by the American Society of Civil Engineers to secure from Congress an appropriation for an investigation of the properties of iron and steel. After the appropriations were secured, he was appointed one of the members of the Testing Board.

Another notable improvement with which Gen. Sooy Smith's name is connected was the introduction into the United States, in association with his son, Charles Sooysmith, of the freezing process of excavation, in the late 80's.

Most of the later years of his life were spent in Chicago, and in that city he was among the first to advocate the sinking of deep foundations for high buildings, carrying piers down to the rock, in place of the raft or grillage foundations that were used for the first high buildings there. During his years of professional work Gen. Sooy Smith acted as contractor as well as engineer on many of his important works. He was associated with the first attempt to build a subaqueous tunnel across the Hudson River at New York City, under Haskins in the late 70's. This was prior to the invention of the tunneling shield and unfortunately ended in failure. In his active years Gen. Sooy Smith was a member of numerous clubs and engineering and scientific societies. He had been a member of the American Society of Civil Engineers since 1872 and was president of the Western Society of Engineers from 1877 to 1880.

Specifications for Treating Wood with Creosote*

By Kenneth Redman†

To a newcomer in the creosoting business the specifications now in vogue for the treatment of Douglas fir on the Pacific Coast seem to be based upon a fundamentally wrong principle. All the more important specifications contain detailed restrictions and limits prescribing exactly the manner of treating, leaving no latitude to the treating engineer, whose business it is to know how to deal with the timber.

When these specifications were drawn up, much less was known of the actual safety limits in using the boiling process than is known today. There have been but slight changes in the specifications, but the treating companies have now learned the limits within which they may safely work. This knowledge has been acquired largely by extended and costly experience. In no instance have the specifications that tell the companies how to treat been of any assistance to them.

It is no uncommon occurrence, when two orders are being handled at the same time—the one under strict specifications and the other with no specifications at all—to have that material which is treated according to the specifications turn out of poorer average quality than the other. The loss due to cullage, however, is borne entirely by the treating company, which is thus fined for complying with instructions. Is this just?

A specific instance, which is typical, may be cited. The specifications of a majority of the railroads stipulate that the boiling of green piling shall be conducted at a maximum temperature of 225° F. To treat in this manner requires 48 to 60 hr., and longer for large pieces. Even then the engineer is at a loss to know exactly when his material is thoroughly dry, for there are often intervals of 3 to 5 hr. during the boiling when the condensation will drop to the required ⅛ lb. per cu.ft.

*Condensed from an article prepared for the Forest School University of Washington.

†Acting Superintendent, Pacific Creosoting Co., Creosote, Wash.

per hr. Were the engineer to press the load the first time that the condensation dropped to the required point, there would result badly split wet material with insufficient protection—that is, culls. This state of affairs caused the companies to operate partly on a time schedule, which is haphazard and unscientific.

Whenever the specifications permit, the present treatment of such material is to boil at 230 to 235° F., and in approximately the last 5 hr. to advance the temperature 5 to 10° more. By this method the time is cut to 32 to 40 hr. The final rise in temperature, when accompanied by no material increase in condensation, is proof to the engineer that this material is in proper condition to receive the oil. Furthermore, as evidence that the companies do not care to boil continuously at high temperatures even when unrestricted, there is in force today a standard specification that permits boiling at 240° F., but the company avails itself of the 240° only in the last few hours of the bath. Were the specifications to permit a maximum of 260°, the company would not alter its method.

Now, it is to the interest of the treating company to produce the best material possible, in order to gain and hold business. Any restrictions that hamper this result work injustice, not only to the company, but to the purchaser as well. The oft-heard lamentation of the inspector that it is too bad the material is spoiled is poor recompense for the culled material accumulating on the hands of the company as it vainly endeavors to treat successfully as it is told.

To keep abreast of all innovations and to try out thoroughly all suggestions for improving present methods, the companies maintain and operate experimental plants, complete in every detail. These experimental plants have furnished data of a practical nature that enable the treating engineer to handle his material with very nearly a certainty. This knowledge, coupled with their extensive experience, justifies the companies in prescribing the precise manner in which the material is to be treated.

Effective specifications for timber treatment should include the following points: (1) Quality of oil to be used; (2) quality of material in the green; (3) quality of treated material; (4) minimum protection required.

Let us see if these points do not protect the buyer's interest fully as well as, if not better than, the present specifications. Buyers are usually represented by inspectors of experience. Practical inspection consists of examining the physical condition of the treated material as regards splits, ring-shake, straightness, etc., together with the stipulated protection. If the material is sufficiently protected and physically fit for the purpose intended, as stated in the specifications, it is accepted for the buyer. Some of the material that is accepted, however, is a "liner"; that is, the inspector is not justified in refusing it, yet it could have been a better product, either as regards soundness or protection.

Now, by granting to the treating company a free rein in the details of its treating operations, but at the same time holding a check on its completed product, the company can so treat that there will result to the buyer a much smaller percentage of "liners" and an average higher-grade material. It is to the buyer's interest, therefore, that he permit the treating company to use all the skill and knowledge at its command in producing his material. The benefit of the foregoing specification to the company is that it will have less needlessly culled material left on its hands.

The writer has discussed this matter with one of the eminent structural engineers of California and has been assured that his next specifications will be framed along the lines here suggested. It is to be hoped that other engineers will see the advantages of such specifications.

Reducing Slippery Pavements in San Francisco

By A. J. Cleary*

Skidding vehicles on wet streets are a menace that the street maintenance and repair departments of the Board of Public Works of San Francisco are endeavoring to overcome. Two distinct modes of protection have been introduced—one for the level business districts, another for the hillside residence sections where the grades are less than 12%. On steeper grades basalt block or vitrified brick is employed.

In the level districts an asphalt wearing surface on a 6-in. concrete foundation is in general use. The advantages of this type are smoothness, noiselessness under traffic, appearance, and economy of construction ($2 per square yard). The most important objection is the slipperiness of such a pavement when wet.

FIG. 1. SHOWING A FINISHED SURFACE; HALF OF STREET RESURFACED WITH ASPHALT AND ROCK

To obviate this objection as much as possible, the Board of Public Works has ordered that the most extensively traveled asphalt streets in the downtown district shall be sprinkled with sand whenever weather conditions make such a precaution advisable. To make this operation as inexpensive as possible, D. J. McCoy, Superintendent of Street Repairs, has invented a special sand spreader (Fig. 3), which can be attached to the rear axle of a motor

*Assistant City Engineer, San Francisco, Calif.

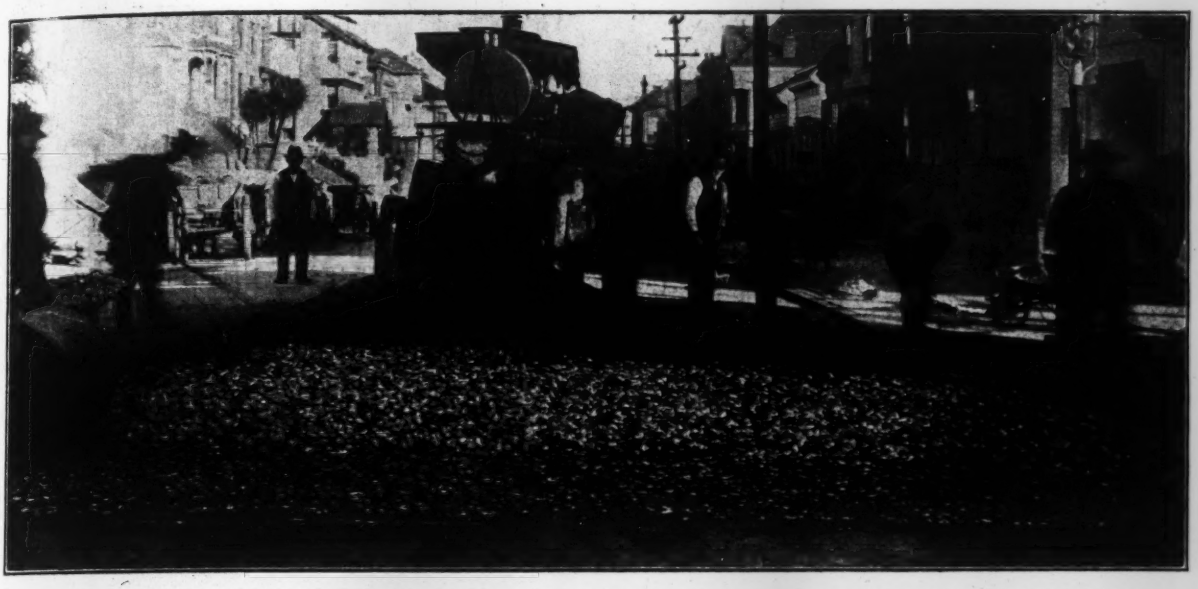


FIG. 2. RENDERING ASPHALT WEARING SURFACE NONSKID BY HEATING IT, DUMPING CRUSHED ROCK, AND ROLLING WHILE STILL HOT

truck, at a total expense of about $275. It has proved to be a very efficient and economical device.

The spreader consists of a flat steel disk that can be rapidly rotated, to which sand is fed through a hose from a hopper on the rear of the truck. The disk is rotated by gear connection to the driving shaft of the truck. On the disk are curved blades that give the sand a strong centrifugal impulse when the disk is rapidly rotated. With the truck traveling on second gear the width of the sand spray is 80 ft., and its density can be regulated by the amount that is fed from the hopper to the disk.

Coarse river sand is best adapted to securing nonskid streets. To prevent slipping, it must be free from clay; and to flow freely, it must be perfectly dry. In San Francisco the cost for spraying 100,000 sq.yd. is $8. This price includes rental of motor truck, services of driver and cost of sand.

In resurfacing asphalt streets in the hillside residential sections the Lutz surface heater has been efficiently used. An innovation introduced by Mr. McCoy has been the spreading of rock on the surface heated by the machine, and rolling before the material cools. This plan has given a satisfactory nonskid asphalt surface. Its only defect is the tendency of the asphalt to spread over the rock under very heavy traffic. Many pavements resurfaced in this manner for experimental purposes several years ago are still in excellent condition. One cubic yard of rock is sufficient for 30,000 sq.ft. Resurfacing costs 5.3c. per square foot in San Francisco.

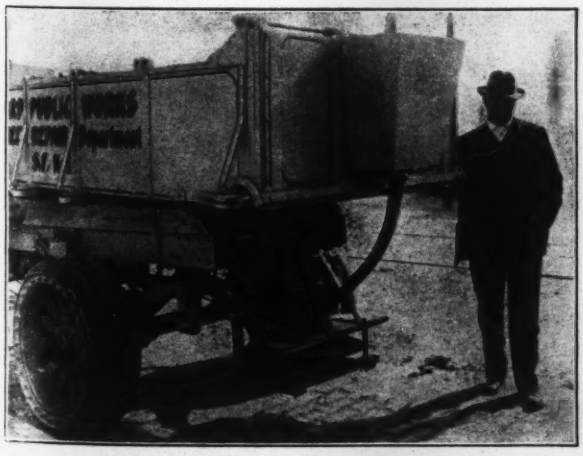


FIG. 3. McCOY SAND SPREADER IN SAN FRANCISCO

Ontario Purchases Big Private Power System

It is officially announced that the Ontario government has completed an agreement for the purchase at $8,350,000 in Ontario 4% bonds of the entire assets of the Electrical Power Co. in central and eastern Ontario. This includes complete control of 22 subsidiary companies now distributing power and light between Toronto and Kingston and as far north as North Bay—namely, Auburn Power Co.; Central Ontario Power Co.; City Gas Co., Oshawa; Cobourg Utilities Corporation; Cobourg Water and Electric Light Co.; Cobourg Gas, Electric Light and Water Co.; Eastern Power Co.; Light, Heat and Power Co. of Lindsay; Napanee Gas Co., Ltd.; Napanee Water and Electric Co.; Nipissing Power Co., Ltd.; Northumberland Pulp Co., Ltd.; Oshawa Electric Light Co.; Otonabee Power Co.; North Bay Light, Heat and Power Co.; Port Hope Light and Power Co.; Peterboro Light and Power Co.; Peterboro Radial Railway Co.; Seymour Power and Contract Co.; Trenton Electric and Power Co.; and Tweed Electric Light and Power Co. This will make the whole of the power of the Trent Valley system available for distribution by the Provincial Hydro-Electric Commission at cost, putting the central and eastern districts of the province in the same position as regards power supply as the western section is with Niagara power. Nearly all the water powers of the Trent River were alienated by the Ottawa government to private interests, and many of them have remained idle. The government has another project under way, by which the hydro-electric system will be farther extended to serve the extreme east of the province.

Field and Office

Electric Shovel with Hydraulic Transmission Gear

Successful application of electric drive to a power shovel has been accomplished by Frank H. Armstrong, Mechanical Engineer of the Penn Iron Mining Co., Vulcan, Mich. On account of the extreme fluctuations of power demand, it was necessary to employ a hydraulic system, inserted as a yielding link between motor and shovel. The several motions of the shovel are actuated by hydraulic cylinders, all supplied from a motor-driven centrifugal pump.

This electro-hydraulic shovel has proved very satisfactory in operation after the elimination of early detail troubles. There are no severe load-peaks on the electric system, the maximum power drafts being only 30% in excess of the mean, which is 100 kw. The peaks, of course, could be entirely eliminated by a larger hydraulic accumulator. The control of the shovel is smooth and accurate. The water pressure is 275 lb. per sq.in. and is obtained with a four-stage centrifugal pump driven by a 200-hp. 1,200-r.p.m. 2,200-volt induction motor. The valves used at first were leather packed, but these gave trouble from sticking. The present valves have no leather in their construction and are proportioned to give a gradual opening and closing of the passages, to prevent water-hammer.

The dipper is hoisted by means of a large single-acting cylinder and plunger. A double hoisting rope passes around two sheaves at the outer end of the plunger, one end of the rope being fastened to the front flange of the hoisting cylinder, while the other is fastened to the dipper, which travels 2 ft. for every foot the plunger moves. The weight of the dipper throws back the plunger when the valve is opened to exhaust. The boom is swung by a double-acting cylinder, the piston rod of which extends through each cylinder head and has a sheave at each end. Thrusting is accomplished by rams acting directly on the diper handle. The ram piping is made with swivel and sleeve joints, so that the dipper can be raised or lowered, or the broom swung or raised.

The shovel is operated by one man, as indicated at the right in Fig. 2. At his right hand is the thrust-control lever, on which is a button for tripping the dipper. On his left is the hoist control. His feet operate the swing

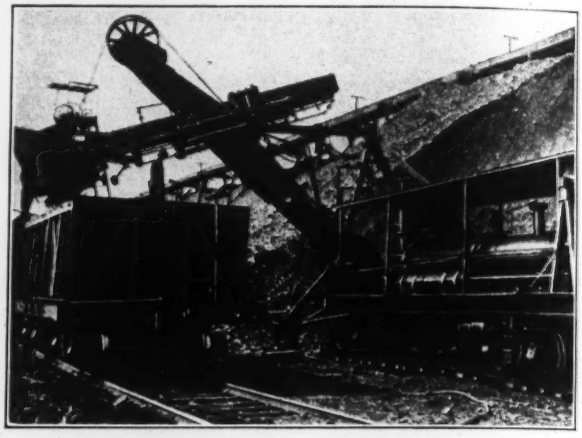


FIG. 1. ELECTRO-HYDRAULIC SHOVEL IN OPERATION

valves. The shovel is propelled by a second motor, the handle of the controller of which is seen under the man's right elbow.

The dipper is tripped by a solenoid shown in Fig. 2 (at the left is the dipper about to dump, and in the middle the trip weight is released and the dipper door open). The average speed of the machine is three or four dippers per minute; 3,000 tons has frequently been loaded in a 10-hr. day.

An advantage of electric power is that when the shovel is not in operation, the current can be shut off and the pump stopped. A possible advantage for city work is the comparative noiselessness of the machine.

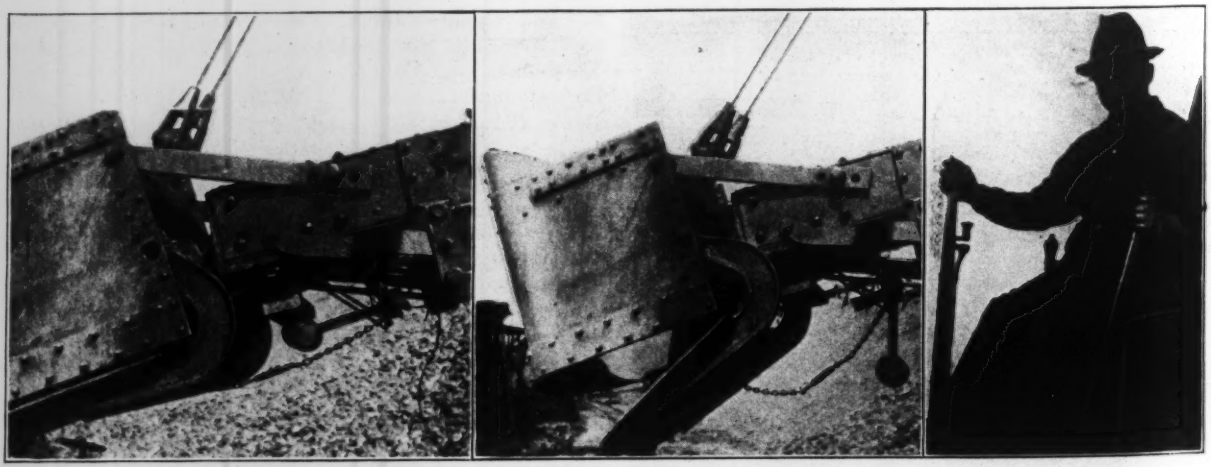


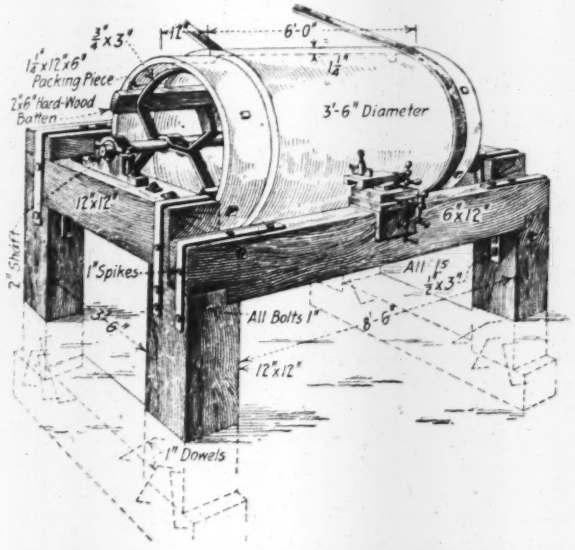
FIG. 2. LEFT—DIPPER CLOSED. MIDDLE—WEIGHT RELEASED AND DIPPER OPEN. RIGHT—THE OPERATOR

Improvised Lathe for Bridge-Pier Cylinders

By Leonard Goodday*

Engineering News, July 8, 1915, contained an article on the method I adopted for making the curved leaves for a clamshell excavator that I manufactured 56 mi. from Adelaide, South Australia, in excavating for 33 pairs of cast-iron cylinders for the railway-bridge piers in the Murray swamp. I now propose to explain how the "making-up pieces" were cut for these cylinders by improvising a rough-and-ready lathe that gave every satisfaction.

With 12x12-in. Oregon logs and half-logs the frame for a lathe was constructed. At each end of it plummer



IMPROVISED LATHE FOR CUTTING BRIDGE-PIER MAKE-UP CYLINDERS

blocks were fixed for a 2-in. shaft having collars to prevent any lateral movement. Two sets of frames were made and bolted to the shaft, as shown in the sketch, 6 ft. apart, in such a way that a cylinder could be securely fixed to them, as follows: Packings 1¼x6x12 in. were placed at the bottom end in the joint, and four 2x6-in. battens were run through the cylinder, against which the two iron-bar frames were fixed—one at each end—with four 1¼-in. bolts through the holes for fixing the cylinders together when in place, the 2-in. shaft being fixed, as shown, by two 1-in. bolts at each end.

The cylinder was then slung by a derrick (which was just in front of the lathe) into place in the plummer blocks, and the "caps" were adjusted. A 6-in. belt from a stationary engine, used to run a crusher, was slipped on the cylinder, which became its own pulley. Iron rods were used to prevent the belt running along the cylinder laterally, the latter of course not being "crowned." The speed for turning cast iron—150 to 170 ft. per min.—was governed by simply regulating the speed of the engine so that the cylinder revolved at from about 14 to 16 r.p.m.

When cut, the plummer caps were taken off, the cylinder was slung, and lifted out with the slings, blocks and fall suspended overhead from the derrick. The lathe was placed near the edge of the river bank, where a chute was built down to the waters edge. After the shaft, iron frames and packing, etc., were taken away, the "making-up piece" was then lowered down the chute and onto the lighter, ready to be carried across the river with the other parts. The slide rest and cutting tools were sent from the Adelaide locomotive shops.

*62 Craig St., Ottawa, Canada.

Status of the Air Tie-Tamper

Pneumatic tie-tamping machines have reached a high state of development in the two years they have been in commercial use. They are now a standard track tool in the maintenance-of-way department of many steam and electric railways. Hand tamping did well enough in the past, but in this day of labor shortage the semi-mechanical method is more desirable. As an indication of the status of this method, the Pennsylvania Lines East alone have 150 of these tampers in service, according to the Ingersoll-Rand Co.

Air tampers can be operated from pneumatic signals or other air-power lines. Pneumatic signal lines are usually at 110-lb. pressure, but the switches will operate satisfactorily on 60 lb., allowing ample leeway for a drop in pressure from any cause whatever. The Pennsylvania operates tampers on these air lines and experiences no difficulty from lowered pressure, although as many as four tampers have been used at one point. Where air is not available, a self-propelled compressor-car is provided. This is built in two sizes—for two tampers and four tampers respectively. The power is furnished by a gasoline engine. The maximum speed loaded is 15 mi. per hr. On electric street and interurban railways power usually is obtained by the use of a motor-driven compressor, mounted for coupling to a work-car or a regular steet-car. Whenever a large number of tamping machines are required, as in laying new track, a standard steam- or electric-driven compressor can be installed in a work-car.

Portable compressor plants of two- or four-tool capacity cost from $2,000 to $2,500 each, making a rather large investment for only one class of work. These power plants, however, can also supply air for such purposes as boring spike-holes, tightening bolts, drilling and reaming bolt-holes and bond-holes in rails, driving rivets and chipping metal in steel-culvert, bridge and cattle-guard work, tamping earth around culverts, driving plug drills in rock excavation, operating pumps, hoists, jacks, concrete mixers, etc.

Tamping bars for different thicknesses of face are provided for tamping the various kinds of ballast. The thickest tamping bar is that used for cinders, earth, gravel, sand or chat. The thinnest head is for rock ballast of 2-in. mesh or larger. The bars in each case are 18 in. long, with a face 3 in. wide.

The "Imperial" tie tamper weighs 37½ lb. Its best operating pressure is 65 to 75 lb., its consumption at 70 lb. being 16 cu.ft. of free air per minute. The two-tool "Imperial" gasoline-engine-driven compressor-car weighs 2,000 lb. (without hose or tampers). It is 9 ft. 9 in. by 5 ft. 7 in. in plan by 5 ft. 6 in. high and will carry 12 men with equipment. The air capacity is 45 cu.ft. of free-air piston displacement per minute. The gasoline consumption at full load is 1¼ gal. per hr. The tank capacity is 15 gal.

Bridge-Track Repairs, Sixth St. Bridge, Pittsburgh

It was recently necessary to make extensive alterations in the street-railway tracks crossing the Sixth St. bridge, Pittsburgh, mainly because of the bad condition of joints, owing to flexibility of supports. The bridge was built in 1893 and has a buckle-plate floor, with buckles turned up. The street-car rails had been bolted to the domes of the buckle plates, which gave a spacing of supports of 3 ft. 2½ in. The rails in use were Lorain Steel Co., Section 107, No. 333. Besides the poor riding qualities the spacing of tracks was so small (only 8 ft. 7½ in.) that any faulty alignment of the track, either vertically or horizontally, allowed the big suburban cars to scrape and often actually block each other.

For these reasons it was necessary to increase the spacing of the tracks and to improve the supports. The two stringers, 18 in. apart, which are shown in Fig. 1, were originally provided to give a cableway for cable cars, but have never been used for that purpose. They happened to be so spaced, however, as to come directly under the line of rails when these were moved down off the top of the buckle plates. The rivet spacing in the top flange of these stringers, connecting to the buckle plates, was 4 in., except at a few points in each panel. A structural-steel chair was designed to engage four of these rivets, and at intervals of approximately 24 in., the rivets were cut out and the chairs riveted on. The chairs were made in a structural shop by bending hot in a bulldozer. Metal ¾ in. thick was used, for stiffness and permanence.

The new tracks are 12 ft. 5⅜ in. c. to c., a considerable increase over the Pittsburgh Railway's standard of 9 ft. 6½ in., but made necessary by the spacing of the stringers.

In laying the new rails care was taken to get the joints midway between supports. Vertical alignment of the rails was secured by using shims under the base of the rail, and horizontal alignment was made with wedges (Fig. 1). The maximum lateral adjustment of ⅞ in. provided by the wedges proved just sufficient to take up all irregularities in the position of the chairs and align the rails. As the concrete base covers these wedges, they are secure against movement after once being adjusted.

The buckle plates were of metal only $\frac{5}{16}$ in. thick. It had been feared that when the concrete, which covered them to a depth of 4½ to 6½ in., was removed, they might be found badly corroded in some places. Actually, they were found in excellent condition and in many cases were as bright as when they left the mill.

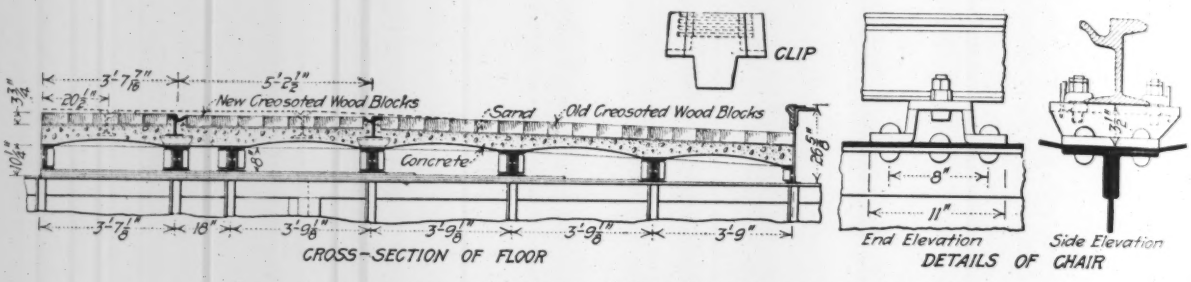


FIG. 1. TRACK DETAILS OF THE SIXTH ST. BRIDGE IN PITTSBURGH

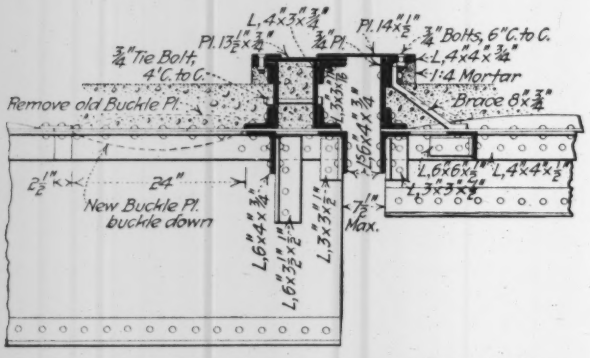


FIG. 2. DESIGN OF ROADWAY EXPANSION JOINT

Heavy new roadway expansion joints were provided, as shown in Fig. 2. For the street-railway tracks a patented expansion joint of arrow-head shape, made by William Wharton, Jr., & Co., Philadelphia, was used. This joint has been very successful in several installations on bridges around Pittsburgh. The wear plates of manganese steel are kept tight against the tapered rail at all temperatures by heavy springs incased in the cast-iron frames.

The repair work was done by Allegheny County, owner of the Sixth St. bridge, under the supervision of J. G. Chalfant, County Engineer, and V. R. Covell, Deputy County Engineer.

A Light Wooden Roof Truss for Canvas Inclosure

By Clyde B. Chace*

The accompanying sketch shows a wooden truss interesting on account of lightness of weight and thorough adaptation to the materials, workmen and methods found on a concrete building.

On the Missouri Can Co.'s new buildings in North Kansas City, Mo., it was found necessary to form and concrete the monitor, or elevated center panel of the roof, during the most severe part of the winter. This panel is 21 ft. wide. Protection was furnished by constructing a canvas shed resting on the adjoining part of the roof, which was already concreted. This shed completed the canvasing in of the portion of roof already concreted, which was heated during the construction of the monitor.

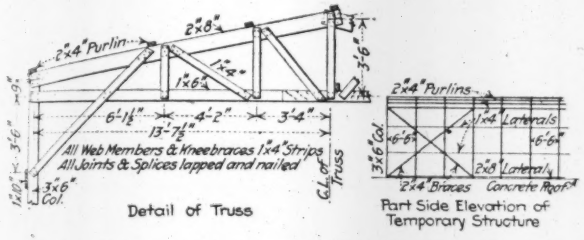
The shed was 180 ft. long. Its frame consisted of trusses supported by 3x6-in. columns. It was made wide enough to allow work on the forms for the columns sup-

*4126 Virginia Ave., Kansas City, Mo.

porting the monitor and high enough to permit a man to walk on the monitor roof without stooping. A clear span of 26 ft. 9 in. was used, and the trusses were spaced 6½ ft.

All lumber used in the shed had previously been used in the forms for the floors below. The 3x6-in. stringers of the flat-slab forms made the columns; the 2x8-in. by 14-ft. joists made the top chords of the trusses; 1x6-in. flooring the bottom chord; and 1x4-in. short ties furnished the web members. Any convenient 2-in. stuff was used for purlins, 2x4's being preferred.

As will be noticed, the trusses were admirably adapted to rapid construction. All joints were lapped and nailed, and little sawing was required, except on the web mem-



WOODEN TRUSS FOR CANVAS HOUSING IN WINTER CONCRETING

bers. A whole truss and its columns formed the unit of fabrication, which was done in a horizontal position as near where the unit was required as possible. Erection consisted simply in tripping up the bent and securing it top and bottom. Diagonals across four bents were placed on each side of the shed at the ends and center. After the first set of braces was in place, the trusses were readily secured by fastening each successive bent to the one just erected. The major portion of the fabrication and erection was done in a single day by the carpenter force on the job.

The trusses were designed by Peter Olson, superintendent for the contractors, R. F. Wilson & Co., Chicago.

Pulling a Displaced Steel Foundation Cylinder

In the construction of the foundation of the new Lincoln Memorial on the Mall at Washington, D. C., the subfoundation was made up of a number of reinforced-concrete piers placed inside steel cylinders ½ in. thick for the lower 20 ft., ⅜ in. thick for the remainder and varying in diameter from 3 ft. 6 in. to 4 ft. 2 in. They are from 45 to 50 ft. in depth. The cylinders were sunk to rock by loading them and excavating the interior earth; the reinforcing steel was then placed and the cylinders filled with concrete.

Several old piles were encountered in the sinking process. Fortunately, most of them came inside the cylinders and could be dug out. One pile, however, caused a cylinder to sink 3½ ft. out of plumb and so disturbed its location as to require it to be withdrawn and sunk again. To pull out the cylinder, a somewhat novel method was used, as described by Capt. James A. O'Connor, Corps of Engineers, U. S. A., in a recent paper in "Professional Memoirs, Corps of Engineers, United States Army and Engineering Department at Large."

First, an air-tight bulkhead of 6-in. timbers was fastened to the top of the cylinder by angle irons. Ground water was allowed to fill up the cylinder to the bottom of the bulkhead; an upward strain of over 50 tons having been put on the cylinder by means of jacks and chains, air under 100 lb. pressure was led to the inside of the cylinder, and repeated impulses were given to the bottom of the bulkhead by opening and shutting the air valve. Careful observations on the gage showed a pressure of 90 lb. per sq.in. for several moments after the valve had been opened. The first twelve attempts raised the cylinder a total of 1 in., the strain on the jacks being taken up each time. On the next attempt the cylinder shot up 15 ft. and was then easily removed.

Specify Amount of Formwork

By S. P. Baird*

Different contractors have different ways of arriving at the cost of concrete, but all their methods take into consideration the amount of forms necessary. When the design of a piece of concrete work is made, it would be an easy matter to calculate once for all the amount of contact surface for the various grades of concrete making up the structure.

For instance, if there were an arch culvert to build on which bids are to be asked, the footing concrete might be as lean as 1:3:6 and no forms required. The bench walls might be of 1:2½:5 concrete and the barrel of 1:2:4. The bench walls would require forms both at the front and the rear of the walls, and with some designs the ring or barrel would only necessitate forms on the under side and at the ends, while the head walls would call for forms both on the sides and on the ends. Following my suggestion the bids would be asked for on something like the following:

100 cu.yd.	1 : 3 : 6	27 excavation
110 cu.yd.	1 : 2½ : 5	9 face; 9 back
90 cu.yd.	1 : 2 : 4	13 face supported 1 face 2 back

Once the system were established it would be intelligible to all and would be interpreted as follows: For the first item it would be 100 cu.yd. of 1:3:6 concrete deposited in an excavation. The surface of the excavation in contact with the concrete would be 27 sq.ft. for each cubic yard of concrete. For the second item the interpretation would be 110 cu.yd. of 1:2½:5 concrete, with 9 sq.ft. of face forms and 9 sq.ft. of back forms per cubic yard of concrete. The last item would indicate that there will be 13 sq.ft. of face forms (the weight of the concrete must be supported at the under side of the arch) for each cubic yard of concrete. The company asking bids would get lower prices, and it would be fairer for the company to calculate it once than for 20 contractors to have to work it out for themselves.

Getting Freight Cars for Automobiles—Charles Shaar, traffic manager of the Packard Motor Car Co., has partly solved the railway-car shortage problem by the erection of sturdy superstructures on railroad "gondolas." These housings, which protect the shipments practically as well as the regular automobile freight cars, are made the means of getting the car back in a hurry. When the covered gondola reaches its destination, the dealer is instructed to bill the superstructure back as a carload of lumber, tar paper, etc., which it really is. In this way the car is returned quickly to the factory and can be used for other shipments.

*Columbus, Ohio.

Concreting Piles with a Tremie

By Rudolph N. Maxwell*

In driving piles for the foundations of the new Hopple St. viaduct at Cincinnati, Ohio, water in many cases was encountered from several old sewers on the site. Raymond concrete piles were used under many of the piers, which made it necessary to place the concrete through this water. In a particularly aggravated case, water from one of tre sewers flowed in over the top of the 20-ft. shell much faster than it could be pumped out.

To correct this condition, three sections of smaller-diameter shells were fitted into each other, forming a cone-shaped tube. A rope was fastened around the top of this improvised tube, which was then lowered into the water-filled pile hole to a point about 2 ft. above the bottom. This inner shell was allowed to project at the top about a foot above the permanent shell (already in the ground). As a single rod was used for the reinforcement of each pile, it was necessary also to hold the rod in place in the center by means of a rope. This complicated matters to some extent, but the rod was useful in stirring the concrete around so that it flowed freely.

The concrete was poured into the improvised tube, or inner shell, and in flowing to the bottom it forced the water up between the two shells. The hollow tube was raised from time to time and the rod worked around simultaneously. Finally, when the tube was entirely withdrawn, the last of the free water appeared on the surface. Shortly after, the pure concrete showed and was found to be of the best and as originally mixed.

Sag and Slope Diagrams for the Steel Tape

The high degree of precision easily attainable in ordinary surveying and engineering measurements with the steel tape is often not realized, because of insufficient attention to the sag and slope errors. Help in dealing with these errors is furnished by two diagrams prepared by W. H. Rayner, of the University of Illinois, who discussed them recently in a general paper on taping errors, before the Illinois Society of Engineers and Surveyors.

The sag correction is read from the diagram, Fig. 1, which is for a 100-ft. tape. The curves relate to different pulls and give the corrections for any weight of tape. Thus, for a tape weighing 1½ lb. the sag correction for 14-lb. pull is 0.04 ft. Ordinary 100-ft. steel tapes weigh from 1¼ to 2 lb. Mr. Rayner believes that the average pull is lower than commonly supposed; in standardizing steel tapes 12 lb. is often used.

The slope correction is given by Fig. 2 to the same vertical scale as in Fig. 1. Like the sag correction it is subtractive; that is, the measured distance is greater than the true horizontal distance. Comparing slope and sag corrections, it appears that a 1¾-lb. tape under 12-lb. pull has the same sag correction when held free horizontally as its slope correction when continuously supported on a 4½% slope. This means that (when no corrections are applied in taping) it is probably better on slopes less than 5% to make measurements with the tape lying along the slope (continuously supported), since the error thus introduced is no larger than the sag correction with the tape freely held horizontal. At the same time the precision is improved by eliminating the uncertainties of plumbing down.

Temperature effect was also mentioned by Mr Rayner as important. The difference in tape temperatures between summer and winter measurements may amount to as much as 100° F., sufficient to cause a discrepancy of 3.4 ft. in a mile or, in land measurement, 0.86 acres in a section.

Concrete Water-Meter Boxes

The water-meter boxes formerly used in Dallas, Tex., were made of corrugated iron and cost the city $1.65 each. Recently it was decided to install many new meters, and a cheaper and more durable box was wanted. The cylindrical concrete box shown by the accompanying illustration was designed in the city engineering offices under the supervision of Hal Moseley, city engineer. A contract for 15,000 of these boxes was let to a local contractor for $1.10 per box, complete, including the cast-iron cover.

The box is shaped about like a barrel cut in two. The concrete is mixed 1:2:2½ with ½-in. crusher-run stone. The shell is reinforced with four vertical wires (No. 10 gage), equally spaced about the circumference, and two hoops. The reinforcement is not intended to add materially to the strength of the box; the vertical wires serve chiefly to anchor the iron casting that forms the cover.

The contractor's plant consisted of a tent and a small gasoline-engine driven batch mixer. Steel forms were

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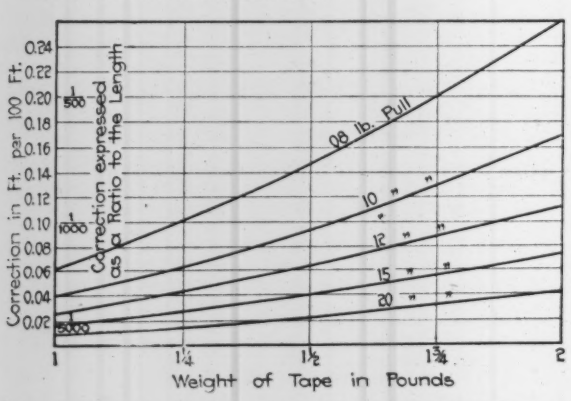


FIG. 1. DIAGRAM OF SAG CORRECTION

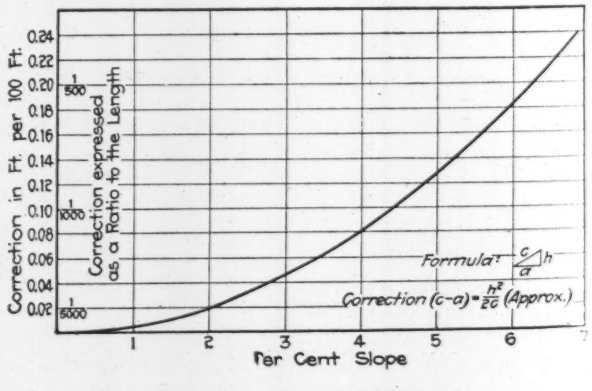
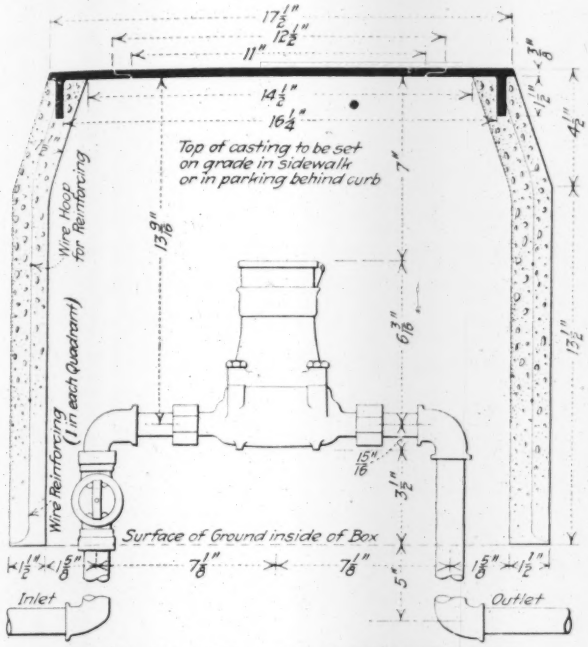


FIG. 2. DIAGRAM OF SLOPE CORRECTION

used. At first, corrugated forms were provided, but later the plain forms were substituted. The intention in adding the corrugations was to lessen the tendency of the box to settle.

With five men and a foreman 125 boxes can be made in an 8-hr. day. They are costing the contractor in



DETAIL OF DALLAS CONCRETE METER BOX

labor and materials $1 each. The top is a ⅜-in. iron casting, weighing about 30 lb.

These concrete boxes stand very rough treatment. The breakage in the first 8,000 made was two. Of course, smooth surfaces and perfectly square edges are not insisted upon.

Machine for Laying Drain Tile Without Trenching

A ditching plow for tile drains, with an attachment for laying the tile underground without digging an open trench, is an interesting machine which is being used extensively in Iowa. It is hauled by a cable- and power-operated drum, like the capstan plow for excavating open ditches that was described in *Engineering News*, Feb. 3, 1915.

The hauling rig, or tractor, is shown in Fig. 1. Mounted on the frame is a Continental four-cylinder gasoline engine (cylinders 5x5 in.) with two bevel-gear drives to a shaft having three sprockets with chains to an upper shaft. This construction gives three speeds in either direction, forward and backward movement being provided by a friction expanding clutch that connects to either one of the two bevel-gear sets. From the upper shaft is driven the shaft with differential gear, and from the latter run chains to the driving wheels. The chains are of the Brampton type, running easily on small sprockets.

Between the rear wheels is mounted a 20-in. drum, also driven by chains. When driving from the slow gear to the drum, the ratio is 1:333. The drum carries 300 ft. of 1-in. cable, extra lengths being attached when laying tile across swamps too soft to carry the tractor hoist. For hauling the cable the tractor is held by 6-ft. anchors of steel channels, which are handled by a block and tackle, the cable leading back to a small drum on one of the shafts. In Fig. 1 the anchors are shown raised, and the tractor is ready to move ahead, paying out its cable.

Plow and Pipe Layer

The plow has a vertical colter 8 ft. long, connected by a beam to an axle (with pair of wheels) to which the hauling cable is attached. The colter is a flat bar, which simply shears through the ground and does not cut a trench. At its lower end is a "mole," or horizontal boring head, 2½ ft. long, with a flat top. The rear end of this is circular and large enough to receive the end of the pipe to be laid. The depth of cut is regulated by means of a jack on the axle, which raises or lowers the front end of the plow beam.

At the rear end of the mole is attached a steel carrier, 210 ft. long and of semicircular section, to receive the tile. When the colter is at its proper depth, a feed hole is excavated behind it to the full depth. A man stands in this hole and places tile on the carrier as it passes beneath him. When the plow has traveled 210 ft., it is stopped, and another feed hole is dug.

Fig. 2 shows the complete outfit. At the left is the tractor, ready to move ahead 210 ft. and pay out the cable. In the middle is the plow, with men sitting on the beam. The handle shown over the wheel is that of the jack previously mentioned. At the right (and just to the right of the tile lying on the ground) is the feed hole ready for the tile layer, with a load of tile at hand

FIG. 1. TRACTOR WITH POWER-OPERATED DRUM FOR HAULING DRAINAGE PLOW

FIG. 2. OUTFIT FOR LAYING DRAIN TILE UNDERGROUND

for him to place in the carrier as it passes along at the bottom of the hole.

The grade is kept by means of a level set to the desired grade and sighted upon a target on the colter. This is under constant observation. Tile 3 to 10 in. in

diameter can be laid in this way at depths as great as 5½ ft. and at an average rate of 100 rods per day at a depth of 4 ft.

The machine was designed and patented by H. M. Fisk, Pella, Iowa, and the first one was built at his shop in 1908. It has been used extensively by C. W. Schwidde, Shenandoah, Iowa, who is a contractor for farm tile drainage and who has furnished information about the machine and its work.

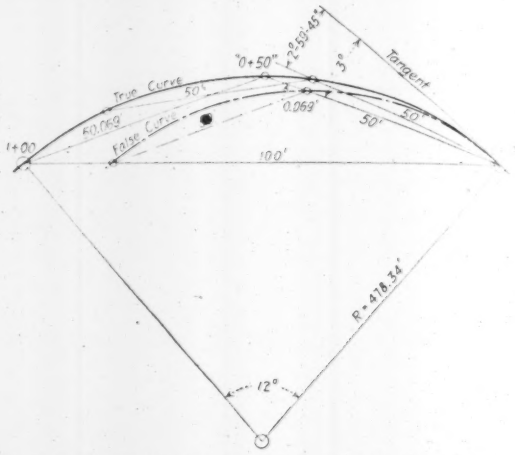
NOTES

Checking Forest Fires With Dynamite—Everyone knows it is a very difficult matter to stop a forest fire after it has gotten a good start. It is also a well-known fact that the trunks and foliage of the trees do not burn readily, because they are green. The fire usually spreads and feeds upon the dry material upon the ground under the trees. Therefore, any method that will prevent the fire from spreading along the ground will generally effectively check it. W. H. Vanderbilt was recently intrusted with the task of stopping a forest fire near Lynnfield, Mass. His method was to put down two parallel rows of bore holes 36 in. apart, spaced 36 in. apart in the rows. Each hole was loaded with a charge of one pound of low-freezing "Gelatin" dynamite. The charges were primed with electric blasting caps and fired electrically. The result was a broad shallow ditch, shown in the photograph. This ditch prevented spread of the fire. This work was done successfully in spite of the fact that the thermometer ranged from 24 to 32 deg. F.—George F. Lord.

PART OF THE DYNAMITED FIRE LINE
Two rows of holes 36 in. apart in both directions; two sticks of "Gelatin" per hole

Repaving Over Public-Utility Excavations in the streets of Los Angeles, Calif., has been done by the street department since July, 1914, at the following rate per square foot: Brick, 35c.; asphalt, 25c.; macadam, 17c.; oil and gravel (also for ungraded-street surfaces), 1c. "These rates," says Thomas Brooks, assistant superintendent of the Los Angeles water department, in his latest annual report, "are slightly in excess of the cost when the water department did its own repaving, but the results are more satisfactory, inasmuch as the City Engineer's office bears the responsibility and expense of any imperfect or faulty work."

Short-Chord Calculation in Curved-Bridge Layouts—In ordinary railway work short chords are often put in with deflection angles in the same ratio to the deflection of the main chord that the length of the short chord bears to the length of the main chord. For the layout of bridges on curves the error of this method is usually serious, especially because in a long bridge it is cumulative. The diagram herewith, by



Lindsay Swan, Kettle River Ry., Penticton, B. C., illustrates the nature of the resulting error. The correct procedure when, say, a 12° curve is to be laid out in true 50-ft. chords is to compute the deflection angle (a) for this short chord (c) by the formula derived directly from the semicircle triangle: $\sin a = c \div 2R$, where R is the radius of the curve. The radius of a 12° curve being 478.34 ft., the formula gives $50 \div (2 \times 478.34) = \sin 2° 59' 45''$, or 15″ less than the deflection angle of 3°, which might be taken in ordinary curve work. For curves of 5° or less the correction becomes negligible.

Three Water-Meter Testing Tanks in One—The water department of Los Angeles, Calif., uses a reinforced-concrete water-meter testing tank 12x12 ft. square on the inside. One corner of the tank is walled off, and in that corner a 22-in. sheet-iron pipe is concreted in. This arrangement gives three tanks with capacities 1,000, 100 and 10 cu.ft. respectively. The three tanks or compartments are connected with a glass tube placed on the outside. This tube is graduated and equipped with a burette float. According to the latest annual report of George Read, meter and service superintendent, this three-in-one testing tank "was not alone necessary for the testing of large meters in regard to accuracy on heavy flows, but it was also necessary in order that the department should know the loss of flow on 3-, 4- and 6-in. services due to the installation of meters, especially when a meter is installed on a service covering both fire and domestic use." Mr. Read continues as follows: "In testing we found a retarding of flow from 2% to 55% through different kinds of meters. The tank also enables the department to purchase a meter more intelligently according to the use and conditions under which the meter is to be used."

Paving by Day Labor at St. Paul, Minn., on 20 jobs cost a total of $334,130 in 1915, compared with contract bids totaling $374,370 and the engineer's estimate of $366,960. The total saving was $40,240, or 12%, as compared with the contract prices, and $32,830, or 9.83%, when compared with the engineer's estimate. On the separate jobs the excess of contractor' bids over actual cost ranged from 2 to 25.3%. In only one case was the engineer's estimate lower than the actual cost, and that was by only 3%. Besides the 20 day-labor jobs there were three jobs done by contract, the prices bid in these cases being below the engineer's estimates and totaling $197,100 against $213,424, or 8.1% in favor of contract work. The city charter provides that the city must advertise for bids on all construction work. The practice with paving is for the city to do the work by force account when the bids are higher than the engineer's estimates, taking into account inspection costs on contract work.

Water-Meter Removals for Failure To Operate, at Los Angeles, Calif., have averaged about one meter removed to each 200 meters in service for the period from 1908 to 1915. On June 30, 1915, the city had 69,628 meters in service. The shop force for keeping these meters in order consisted of a foreman, four repairmen, one man for testing, a store clerk and a janitor. Practically all of the repairing is done with three men.

Editorials

Increasing Loads and Stresses on Highway Bridges

Brief reference was made in the issue of Mar. 16, page 533, to an investigation of the strength of highway bridges in New York State now being made by a legislative committee. Some paragraphs from the preliminary report of this committee present the highway-bridge situation in such a striking fashion that they are worth quoting:

> The general character of the traffic over highway bridges in the State of New York has changed more since the year 1900 than it changed during the whole nineteenth century.
>
> Vehicles propelled by mechanical power are increasing in their size and weight and their consequent stresses upon bridges nearly as fast as they are being increased in number.
>
> The usual requirement of strength for highway bridges in New York State in the year 1900 was approximately the same as the requirement of strength for such bridges in the year 1800. The requirements of strength for highway bridges in the year 1916 are approximately four times as great as in the year 1900.

A vast amount has been published concerning the necessity of improving road surfaces to carry automobile traffic, but very little concerning the necessity of rebuilding highway bridges to make them safe for heavy high-speed machines. There is little doubt that the State of New York, with its dense population and wealth, has bridges on its main highways which are at least as safe and strong as the highway bridges in any state of the Union. It is estimated, however, that to bring the bridges of New York State up to a safe strength to carry present-day motor vehicles would cost at least $30,000,000. If this is the estimate for a single state, one can form some idea of the enormous outlay that will be required to build safe highway bridges throughout the United States or even throughout the limited sections where the use of heavy motor vehicles may be expected in the near future.

In this connection it is well to place emphasis on an important resolution adopted at the recent Pittsburgh meeting of the American Road Builders Association:

> Resolved, That this association urges that laws be passed and enforced in each state establishing reasonable limits for the weight, dimensions and speed of heavy motor vehicles.

At the present time engineers responsible for highway-bridge design are literally at sea in determining what maximum loads should be specified for safe construction. The automobile-truck manufacturers unfortunately have taken the very narrow view that legislation fixing maximum weights for motor vehicles should be opposed and have made the absurd demand that bridges should be built strong enough to carry any load that may come up them.

The predicament of the highway-bridge designers faced with this demand may well be compared to the situation of a railway chief engineer who should be instructed by his superior officer that all limitations as to locomotive weights and wheel loads in the rolling stock used on the road had been abolished and he was henceforth to design his bridges for any load that could come upon them.

As has been frequently pointed out in these columns, more damage may be done to a road surface by a few exceptionally heavy vehicles passing over it than by all the rest of the traffic. Similarly, it is the few exceptionally heavy vehicles that stress bridges beyond their safe strength and which are responsible for many of the too common highway-bridge accidents. Enough experience has now accumulated in the operation of motor trucks to indicate that, except where a truck is to be used entirely on paved city streets, a vehicle of moderate load capacity will render more economical service year in and year out than an abnormally heavy vehicle. Builders of motor trucks will in the long run advance the interests of their industry as well as the interest of the public if they will join with highway engineers in the framing of reasonable restrictions for the weights of such vehicles.

A Changing Labor Market

Less than a year ago, cities all over the country were wrestling with the difficult problem of unemployment. The number of men and women destitute through lack of work overtaxed the capacity of all the organized charities and formed a social and economic problem of the first magnitude.

In less than 12 months the country has passed from one extreme to the other, and at the present time there is a scarcity of labor in comparison with the demand such as has not been witnessed for a generation. This condition is only in small part due to the demand for workmen by factories making goods for export to the warring nations of Europe. That demand has had a large influence indeed in raising the market prices for labor, but other causes have operated to reduce the supply of labor hitherto available.

For the past 20 years some hundreds of thousands of immigrants from Europe have annually been poured into the American labor market. In the summer of 1914, however, with the outbreak of the war, the inflow of immigration was stopped as if a gate had been shut. In its place there has been a considerable flow of foreigners back to Europe. The effect of this on the labor market in America was masked for a time by the general paralysis of business, but with the revival of business in the latter half of 1915 the diminished supply of labor became evident.

During the construction season of 1916 efficient labor is going to be difficult to obtain and to hold, and increases in wage scales are reported on every hand. The prompt adjustment of the wage scale by the conference committee of the bituminous coal-mine operators and representatives of the miners' union appears to have been due, in part at least, to realization by the operators that the law of supply and demand would make necessary an increase in the scale of wages anyway, in order to hold their employees. Necessity is thus made a virtue.

A good illustration of the changed conditions in the labor market is reported from Chicago. The Civil Service Commission of Chicago holds examinations of applicants for employment at stated intervals. Last August examinations were held in 25 wards of the city of applicants for employment as laborers, and 1,668 men took the examinations. In February similar examinations in the same wards were taken by only 501 candidates.

There has been much speculation as to what will take place when the war comes to an end, and it has been freely predicted that a flood of immigration from Europe such as has never before been seen will flow toward America. It is surprising to learn that some careful expert investigations and inquiries which have recently been undertaken by large employers of labor indicate that instead of immigrants coming here when the war ends, there will probably be a large emigration from America to Europe as soon as the war is over. The governments of the warring nations, which have suffered such heavy losses from their working force, are likely to place every obstacle in the way of the diminution of their remaining labor supply by emigration to foreign lands. This will hinder the renewal of the great tide of immigration that formerly flowed to the United States. In addition, there are a vast number of foreigners in the United States who are held by ties of home and relationship to their native land and who will be drawn back there as soon as normal conditions are reëstablished in Europe.

Of course, other conditions not now foreseen may come in to modify this result, but it is of interest to know the results of this expert investigation with respect to the future labor supply.

Preventing Corrosion in Piping Systems for Hot Water

Three years ago, in *Engineering News*, of Feb. 13, 1913, there was published a valuable paper by F. N. Speller, of Pittsburgh, Penn., describing investigations to determine the cause of the rapid corrosion that frequently takes place in the piping used for hot-water supply systems, especially in hotels and apartment houses where the quantity of water heated is very large. As many readers will doubtless recall, Mr. Speller's investigations, carried on in connection with the research laboratory of the National Tube Co., showed that the corrosion of water pipes in hot-water supply systems is due chiefly, if not wholly, to the dissolved oxygen in the water, which is released when the temperature of the water is raised. Corrosion from this cause has in some notable cases ruined the hot-water piping systems of large hotels within two or three years after their installation. A method that has been found successful in preventing this corrosion is heating the water in open tanks prior to its circulation through the system, whereby the dissolved oxygen is driven off.

Additional information on the same subject was given by Mr. Speller in a paper at the annual meeting of the American Society of Heating and Ventilating Engineers. After reciting further investigations in connection with bad corrosion of piping systems Mr. Speller refers to some new methods that are being developed for the protection of piping from corrosion. It has been found that, while the piping in certain exhaust-steam heating systems was corroded very rapidly, other piping was almost entirely free from corrosion; and the cause in the latter instance has been traced to a small quantity of oil carried forward with the exhaust steam. Mr. Speller suggests that in certain cases where the presence of oil in the pipe would be unobjectionable a small quantity of oil could be systematically fed into the current of steam to protect the pipe interior.

Another plan that has been tried on a small scale is the removal of dissolved oxygen from the water prior to its circulation through the system by passing the water through a chamber filled with finely divided iron. Experiments were first made using clean iron turnings in the chamber. Later, there was substituted in place of these a mass of sheet iron so formed as to provide a large number of channels through which the water would flow. Experiments with this apparatus showed a reduction of oxygen content in the water circulated from an original content of 8 or 9 c.c. per liter to 0.1 to 1 c.c. per liter. Other experiments have shown that, with an oxygen content of 1 c.c. per liter or less, corrosion is reduced to a negligible amount.

It will be understood that these methods of de-oxygenation of water are suggested as alternatives when for some reason or other the open feed-water heater method of de-oxygenation is objectionable. Mr. Speller estimates that with proper attention to de-oxygenation of water before entering a hot-water piping system it will be possible to make the life of the piping four or five times as long as it would be otherwise.

It will be readily appreciated that in most cases where piping systems suffer from corrosion the loss is not merely the value of the piping destroyed. Oftentimes the injury to decorations, wall finish, flooring, etc., and the interference with the use of the building during the necessary repair work may together make the damage due to the corrosion of the piping a dozen or twenty times the value of the piping injured. Mr. Speller's investigations of methods for protecting such piping, therefore, are of great value.

Value of Expert Advice

Sound and illuminating ideas on expert advice are expressed in a few brief and forcible sentences in the latest annual report of A. H. Dimock, city engineer of Seattle, Wash. After urging the importance of planning city improvements to meet the needs of the future, Mr. Dimock says:

> **In this connection I would urge the value of expert advice. No one man—no matter how expert he may be in any particular line—is capable at all times and under all circumstances of exercising a calm and unbiased judgment. The value of expert advice lies largely in the thorough discussion of any given problem from several points of view by men properly qualified to weigh and evaluate the conditions underlying such problems. The tendency of such discussion must necessarily be to even up the idiosyncrasies of the individual engineer and to secure a better-rounded and more harmonious plan.**
>
> **There is, however, some tendency in this city to accept the advice of any experts who may be called in as binding. This tendency should be discouraged for the reason that the judgment of the expert is only one factor entering into the solution of the problem. His opinion will naturally have greater or less weight depending upon his eminence in his profession and his experience in dealing with familiar problems.**
>
> **The judgment of these men who have given years to the study of any particular local problem is, however, an element**

which must also be considered. These men would be the first to appreciate at its true value the testimony of outside experts. The value, however, of reports and opinions of those who have given their lives to the study of certain specialties is nevertheless very great indeed, and such advice should always be secured before the settlement of any important problem. The City of Seattle can make no investment which will return a larger percentage of profit than to secure the best brains of the country.

An interesting subject for consideration is the extent to which Mr. Dimock's warning as to the danger of regarding expert advise as absolutely binding deserves attention in other places than Seattle. To outsiders who have followed happenings in Seattle for a dozen years past, it does not seem that the governing body of that city has ever given overmuch heed to well-selected expert advice, but doubtless Mr. Dimock knows whereof he speaks.

Army-Engineer Examinations

Announcement has been made by the Chief of Engineers of the United States Army that the next examination for appointment as second lieutenant in the Engineer Corps will be held about August 21 next. It will be remembered, however, that a prerequisite for taking this examination is qualification for appointment as junior engineer in the Engineer Department at large. The examinations for this latter position will be held by the United States Civil Service Commission, Apr. 12 and 13, 1916.

Those young engineers, therefore, whom the recent commissioning of six civilians in the Engineer Corps has encouraged to aspire to similar appointments must be prepared to take these April examinations, if they are not already qualified either by previous examination or by their positions in the Government service. While there has been no official intimation of the fact, it is more than probable that, in view of the current military agitation, the civilian appointments this year will be greater than ever before.

Movies Keep Workmen on Job

It is a very common complaint of contractors, particularly those doing work in remote sections of the West and those who are employing chiefly unskilled labor, that it is exceedingly difficult to hold the men on the work. After every payday a large proportion of the men make for the nearest town to spend their money, and it is a common saying that three gangs are required to keep the work going—one on the job, one going away and one coming back after sobering up.

A lumber company in northern Wisconsin has introduced motion pictures this year as a means of keeping its workmen in the logging camps contented, with, it is stated, remarkable results. In former years the crews in the camps of the Guerney Lumber Co. were almost entirely changed every 30 days. After a man had gone to the city to spend his wages, he was quite as likely to go to some other camp for a job as to come back to his old place.

As an experiment the company this year secured a motion-picture machine and an operator, and a motion-picture show is given every night. The old difficulty with constantly changing crews has disappeared. The men are charged a small admission fee, which they willingly pay, and the little building where the pictures are shown is crowded every night. The men stay contentedly on the job and are in much better physical shape than under the former conditions.

Vacancy for County Engineer; Salary, $300 per Year

Engineers in the public service and those ambitious to enter it will no doubt be interested, though not necessarily pleasurably so, in the value placed upon such engineering ability by the Nodaway County Court of Missouri. The following comment is from the Maryville *Tribune* of Feb. 11, and its facetious vein awakens hope that even the layman regards $6 per week as an insufficient "honorarium" for faithfully discharging the duties of county engineer:

> Wanted—One first-class county highway engineer, of assured ability; salary, $300 a year.
>
> Anybody who wants the job, can prove that he is capable of doing the work necessary and is willing to accept the position of county highway engineer at a compensation of $300 a year may get the appointment upon application to the County Court. Not so fast, gentlemen; give the head of the line a little room.
>
> For that's the salary the County Court has offered the man who wants to accept the job. The court received two applications—one from the former engineer, John H. Clary, at $1,500 a year with expenses; the other from the present engineer, J. E. Reese, who offered to fill the office another year at a salary of $720, paying his own expenses. Both were rejected.

Engineering News is unacquainted with conditions in the county in question and, therefore, leniently concludes to suspend sentence on the seemingly penurious Nodaway County Court.

The bill making it possible for the local health boards in New Jersey to transfer the inspection and testing of new plumbing to the building department, whenever any such board decides that plumbing control is not its proper function, is a move in the right direction. The bill was proposed by the New Jersey Health Officers' Association and has been indorsed by the State Department of Health. The latter rightly urges that plumbing has comparatively little relation to public health; that building operations are hindered and unnecessary annoyance and expense caused by the duplicate filing of plans and duplicate inspections; and that "it is imperative that the energies and resources of local boards of health should be concentrated on those lines of work which have the most direct effect on the saving of lives and prevention of sickness." It might be added that some of the less progressive boards of health think their duties begin and end with plumbing and nuisance inspection and expend their meager appropriations for such work, to the neglect of vital health issues.

A new and telling good-roads slogan, "365-Day Roads," was used in working up attendance and interest at the highway-engineering conference held early this month at the Kansas State Agricultural College, Manhattan, Kan. The pertinence and efficiency of such a motto are further shown by the existence of a "365-Day Road Club," which has been organized in Kansas. These facts need no comment for those who know what country roads are for many days of the year in the sticky-soil portions of the Middle West, as well as the South.

Letters to the Editor

Rating the Qualifications for Success in Engineering

Sir—I read with much interest the editorial in *Engineering News* of Mar. 2, 1916, on the qualifications for success in engineering and I am very glad you expressed yourself in the way you did. It is safe to say that few men can judge accurately the causes of their own success or failure, much less that of their neighbors. As an engineer rises in the world, his technical knowledge becomes so much a matter of instinct that he almost forgets that he has it. His knowledge becomes broader and less detailed. He forgets all, or nearly all, the formulas for integration, but he understands the broad principles of integral calculus better than the young graduate.

I am sorry for the apparent tendency to underrate the value of technical training. The vast majority of engineers are engaged on work that is principally technical. The personal qualities mentioned, and rightly, as of paramount importance to the highest success of an engineer—or almost any other kind of man, for that matter—are pretty fully developed at least five years before the young man ever enters a technical college and are due more to his family and neighbors than to anybody else.

If one reads history carefully, he will see that a long and bloody war is a prelude to a more or less complete stagnation in the intellectual progress of the people involved. They are at present engaged in a wholesale slaughter of the flower of European manhood, and the end is not yet. The old men are left—but not for long—and there are few young men coming up to take their places. It will be largely the duty of Uncle Sam and his nephews and nieces to carry the torch of progress and learning for many years to come. It therefore behooves us to play our part with the highest skill and train ourselves assiduously to take and hold the place that will be waiting for us. WILLIS WHITED.

Harrisburg, Penn., Mar. 8, 1916.

Sir—Your editorial on "Rating the Qualifications for Success in Engineering," in the issue of Mar. 2, was interesting and to the point. I received one of Professor Mann's cards and in answering I rated "character" first and "knowledge of the fundamentals of engineering science" second, adding that if a man did not have this knowledge he would not be an engineer, although he might be a successful business man. A man cannot be a "successful engineer" unless he has character; but a knowledge of his profession is certainly a prime requisite for success for any man, no matter what that profession may be.

The conclusions drawn from answers to such inquiries are not likely to be of much value in helping determine the best methods of instruction for students of engineering; but Professor Mann's work has been of great value, inasmuch as it forcibly calls the attention of the young men in the profession to the fact that so many of the older members place integrity above every other element requisite for success, not even excepting professional knowledge. PALMER C. RICKETTS.

Troy, N. Y., Mar. 4, 1916.

Sir—The result of the Carnegie Foundation classification and weighting of the desirable qualifications of young engineers based on a canvass of several thousand practitioners does not constitute a very tangible or adequate guide to those directing our great technical schools.

Out of the six counts on which judgment is rendered, five—character, judgment, efficiency, understanding of men and technique of practice and of business—are the qualifications desirable in all young professional men—surgeons, lawyers, engineers and divines—who are to serve well and reach the high places in life. If the words "technique of practice" be not construed too narrowly, these qualifications apply equally well for young business men—bankers, manufacturers and merchants. In short, they mark an all-round promising young man and are almost as obvious as good health and cleanliness.

Perhaps the conclusion that, after all, an engineer is just a man and primarily must have the qualities that win in all vocations and professions is the important vital truth in the verdict rendered. If these qualities exist, add a knowledge of the fundamentals of engineering science and something of its technique, and we may expect a successful engineer.

Those of us who are directing young men through a five-year collegiate course in engineering—in which more than 85% of the work pertains to the science and technique of engineering—must be keenly cognizant of the fact that character molding, scientific attainment and efficient practice are all going on at the same time in this plastic period of youth.

In the end the product of our technical schools is an apprentice in life and in engineering. In the first ten years of his professional life, qualities of judgment, perspective, responsibility, resourcefulness, accuracy and executive ability will emerge and intensify. These qualities, like winter apples, may not ripen as early as the simpler qualities of integrity and industry, and first employers must expect only reasonable development.

If in our education of engineers we could only reach back and educate their grandfathers and grandmothers, their fathers and mothers and guide our prospective students from kindergarten to college, perhaps our product might be better—but at the present time I believe it is good at Minnesota. FRANCIS C. SHENEHON,
Dean, College of Engineering,
Mar. 13, 1916. University of Minnesota.

Sir—The current inquiry on behalf of the Carnegie Foundation for the Advancement of Teaching, bearing on a proposed standard for engineering graduates, which is also to be used as "a standard in developing staff or-

ganizations and curricula and in selecting efficient methods of instruction" has already received editorial consideration in your issue of Mar. 2. For the sake of brevity I shall venture to state my views categorically and seemingly, at least, somewhat dogmatically, as follows:

1. It may be doubted that any artificial standard can be devised for gaging the merits of men of widely varying characteristics in relation to unknown duties of equally diversified kinds. It would be sufficiently difficult to establish a fixed standard for a given position, much less for a profession such as engineering, of the broadest range.

2. The six factors and their relative weights in the standard reported by Dr. Mann are suggestive of criteria for ultimate rather than initial professional fitness. Different standards, to say the least, should be applied in testing the qualifications of young graduates for service as professional privates and those of more seasoned men for positions of leadership, although both, especially the latter, are so varied in their requirements that no single standard may be expected to serve for either.

3. The specifications for young graduates may be limited essentially to character and a knowledge of engineering fundamentals as to theory and practice, with incidental regard to personality, according to the requirements of the position and in particular as to the absence of pronounced personal crotchets, without any attempt at an exact quantitative evaluation of the several elements. With such "initial qualifications" assured, the graduate and his prospective employer may well rest content, leaving the question of professional growth to the influence of professional soil and environment, by which alone it can eventually be answered.

4. The personal qualities for ultimate success in engineering and, indeed, in every other field of human endeavor are in the main inherent—that is, capable of development, but not of creation. Moreover, the extent to which such qualities may be capable of development can be determined only through the actual seasoning process in practice and cannot safely be predicted even from an intimate acquaintance with the young aspirant at graduation.

5. Standards determined after full discussion by a group of men, carefully selected for their fitness, individually and compositely, may fairly be expected to command greater confidence than averages struck from over a thousand miscellaneous replies to a circular inquiry. In support of this view the present rating of only 13% for a knowledge of engineering fundamentals on the part of young graduates may be cited without comment, from which it is rather difficult to refrain.

6. The six factors in the present tentative standard fail to take account, or adequate account, of the vital element of personality, with such important attributes as presence, temperament, forcefulness, self-reliance, tact and affability; and that of general culture, in the sense of intellectual development along nontechnical lines, breadth of interests, and accuracy and readiness of expression in speech and writing. And yet it can hardly be doubted that these two elements—personality and culture—are of very great importance, and not infrequently of governing importance, in influencing elevation to the highest professional levels. It is of course conceded that the acquirement of an effective personality depends essentially on traits inherent in the individual, but is that not true also of executive ability? Why then discriminate?

7. In determining the relative merits of individuals it may be doubted that any artificial scheme by which the value of a man is estimated, as the sum of the products found by multiplying assumed grades for various characteristics by factors representing their assumed relative weights, can reasonably be expected to supersede the usual practice by which men are "sized up" and appointed or promoted on their known personal and professional records. If in the case of young men the latter is not adequate, an examination test may be readily applied.

8. Finally, as to the practical possibility of applying any fixed standard or set of standards to engineering curricula and methods of teaching, which must necessarily also include teachers, equipment, administrative methods, entrance requirements and the degree of their enforcement, I confess that I should prefer to refrain from comment until the proposed methods of attacking a problem of such bewildering complexity shall have been more definitely enunciated.

That much good will flow from the current investigation of the present status of American engineering education and the possibilities of improvement is to be confidently anticipated, even though the prospects of practical results from the particular phases of this investigation here discussed may not seem very hopeful. Though recognizing that there is always room for improvement, the need or possibility of sudden revolutionary changes in American engineering education is not apparent to the writer.

EDGAR MARBURG.

University of Pennsylvania, Philadelphia, Mar. 16, 1916.

Engineer's Cost Estimate

Sir—While I do not believe that any bidder has a right to base his cost estimates on the estimate made by the engineer who designed the work and while I believe it is the duty of every contractor to know enough about costs to make up his own estimates, I must take exception to the manner in which "An Engineer" arrives at the cost of a cubic yard of concrete, on page 477 of *Engineering News* of Mar. 9.

To begin with, estimating reinforcing steel and forms by the cubic yard instead of by the pound and square foot is not a scientific method. However, "An Engineer" states that "mixing and placing and water and waterproofing could cost $1 per yd. under difficult conditions." I believe that $1 per yd. for mixing concrete and placing it in a wall 33 ft. high is not enough; and that to it must be added the cost of 131½ sq.ft. of waterproofing (one side) at 1½c., which equals 20c., and the cost of 27 sq.ft. of surfacing (two sides) at 1c., which is 27c., making a total of 47c.

I have allowed only 1c. per sq.ft. for surfacing, on the assumption that the job did not require more than the most perfunctory finishing, but even the figures I have given show an increase of 4% in the cost of the concrete.

In these days of sharp competition a 4% increase in cost would have a very serious effect upon a contractor's profits.

CHARLES F. DINGMAN,
Flynt Building and Construction Co.

Palmer, Mass., Mar. 10, 1916.

Rusted Pony Truss Collapses at Johnstown, Penn.

SYNOPSIS—Pony-truss highway bridge with some members in advanced stage of corrosion. Heavy overload, considering reduced sections. Failed slowly and settled uniformly, owing to rigidity of crossframing. City engineer had recommended repair or replacement.

On Mar. 21 a single-span pony-truss highway bridge across the Conemaugh River at Johnstown, Penn., collapsed under a heavy load of street cars and foot passengers. While the manner of failure and the low clearance of the structure prevented many casualties, the accident was noteworthy and contains many lessons. At the request of *Engineering News*, C. E. Chase, Inspecting Engineer for Modjeski & Angier, Pittsburgh, went to Johnstown to investigate the failure. There are appended a report by Mr. Chase, illustrated with drawings, and some comment by Edward Godfrey, also of Pittsburgh.

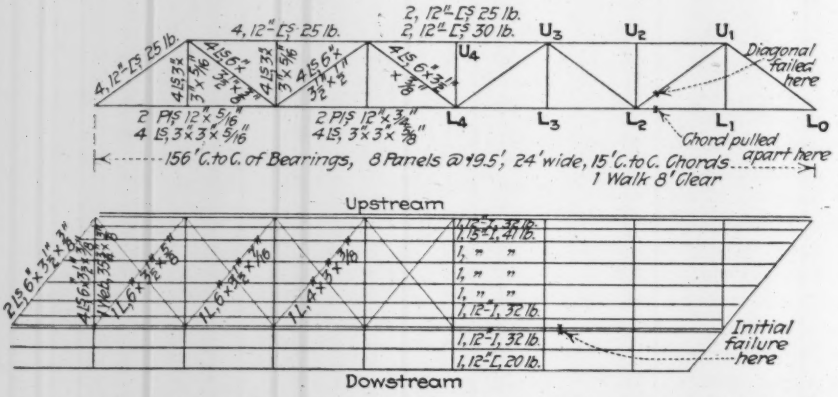


FIG. 1. TRUSS DETAILS OF WOODVALE BRIDGE ACROSS CONEMAUGH RIVER

These details were taken from the original drawings of the bridge, but the specifications under which the bridge was designed and the loading details are not available. The bridge has evidently had no maintenance and a high degree of corrosion is apparent in practically all of the members. The section shown in Fig. 2 is typical of most of the members. Corrosion is more advanced at the level of the wooden floor, which fits tightly against the metal parts of the trusses.

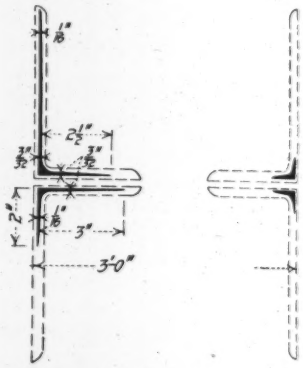


FIG. 2. CORROSION LOSS OF U_1L_2 (DOWNSTREAM)

Original section, shown dotted, four 6x3½x⅝ angles = 13.68 sq.in. Present section, shown in black (estimated) = 2.00 sq.in.

Report on Collapse by Clement E. Chase

Mr. Chase's report is as follows:

That a pony truss has merits of its own—when it comes to failure of the span—is a conclusion that might be drawn from the failure of the Woodvale bridge over the Conemaugh River at Johnstown, on Mar. 21. A large loss of life could hardly have been avoided but for the facts that there was no overhead bracing and that the failure of one truss immediately worked through the rigid floor-beam connections to cause the failure of the other and so allowed the span to settle vertically instead of overturning.

The accident happened just after the day shift had left the Franklin plant of the Cambria Steel Co., when five trolley cars and about 500 men, jammed into the cars and on the footwalk, were waiting on the bridge for the passage of a train on the Pennsylvania R.R. track at the west end of the bridge. The failure was fairly slow and progressive, as an employee of the Cambria Steel Co. in a near-by office overlooking the bridge had time to call police headquarters on the telephone after the first sound of failure and send word that the bridge had started to settle and then that it had failed. The significance of this is in the indication it gives of the sequence of the collapse. As the bridge settled, the trolley cars jammed together in the center, pulling on a sixth car. The men escaped out of the windows, and but seven injuries occurred, only one of which was serious.

The structure was a skew pony-truss span with a 21-ft. roadway and one 8-ft. sidewalk and was 156 ft. long c. to c. of end bearings. It was built in 1895 by the Edge Moor Bridge Works, and apparently was constructed of steel. The dimensions and sections were as shown in Figs. 1 and 3. The bridge originally was designed with both trusses of the same weight, with but one cantilevered sidewalk and no provision for trolley cars. When the single track was laid, it was, with rare judgment, placed nearest to the truss that already carried the sidewalk in addition to its share of the roadway burden, with the result that under the conditions of loading at the time of collapse probably 80% of the load went to that truss.

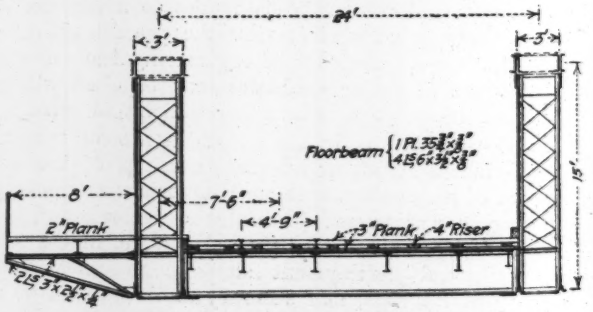
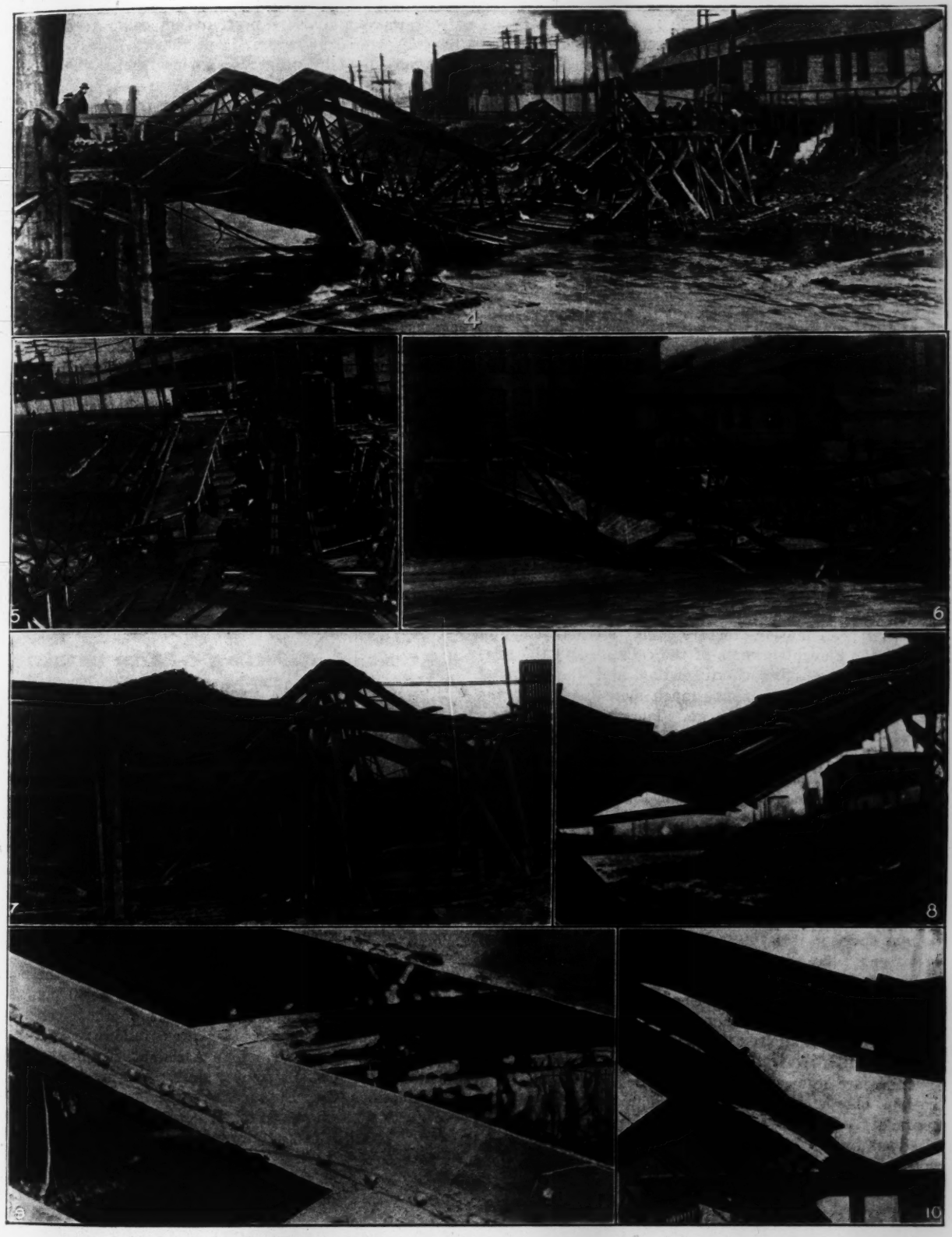


FIG. 3. CROSS-SECTION OF WOODVALE BRIDGE

The design unit stresses seem to have been moderate, probably about 9,250 lb. per sq.in. for live-load stresses in tension, with 18,500 lb. per sq.in. for dead-load stresses,



FIGS. 4 TO 10. VIEWS OF COLLAPSE OF WOODVALE BRIDGE AT JOHNSTOWN, PENN.

Fig. 4—From downstream side, Franklin Works on east bank. Fig. 5—Looking east along top chords. Note that top chord of first truss to fail (on right) did not buckle much laterally, but upstream truss (on left) did buckle opposite broken diagonal. Fig. 6—Eastern end of span from upstream. Fig. 7—East and downstream truss. Note the diagonal U_1L_2 immediately under and parallel to top chord U_1U_2. After failure of the diagonal this panel probably distorted and caused the noticeable settling of the bridge before the bottom chord failed. Fig. 8—Fracture of top chord between U_2 and U_3 of upstream truss. Secondary failure at rivet holes. Fig. 9—Bottom chord L_0L_2 showing corrosion. Outstanding leg of angle entirely eaten through. Fig. 10—Initial break in diagonal U_1U_2.

with unit loadings of about 1,500 to 1,600 lb. per lin.ft. of bridge for live-load and about 2,000 lb. per lin.ft. for dead-load. Although the flooring had been changed from that of the original design, it is not apparent that the dead-load had been greatly increased. The actual dead-load has not been checked, but the two 7-in. girder rails, added floor planking and gas-main pipe possibly amounted to 200 lb. per sq.in. Estimates of the load on the bridge vary from 60 to 85 tons, or a live-load of from 750 to 1,100 lb. per lin.ft. of span at the time of collapse.

Considerations of loading seem rather a waste of time, however, when the condition of the structure is known. Apparently, past Johnstown administrations had expected the bridge to stand up on its record after the steel had rusted away, for the corrosion was most obvious even above the floor line. The space between the legs of the angles composing the diagonals and posts and between the backs of the pairs of channels forming the top chord was entirely filled with heavy scale. The wastage of metal at the level of the timber deck was, as usual, much worse than in the exposed positions. Fig. 9 shows a rather obscure view of one of the inverted T-shaped sections of the bottom chord, with outstanding legs of the angles completely rusted through. The present city engineer, taking office on Jan. 3 of this year, had vigorously condemned the condition of this span, along with others, to the city authorities on Jan. 28 and had asked for an appropriation to make plans for, and execution of, repairs.

Local opinion inclines to the belief that the downstream bottom chord, at about the L_2 point, failed first. This shows a typical tension fracture, "silky angular"; but in view of the known slowness of the collapse and the relative wastages of this chord section and the diagonal U_1-L_2 just above it, it seems much more likely that the diagonal was the first to let go. The chord section may have lost as much as 30% of its original sectional area, but this is quite outdone by the diagonal, which had lost 85%. Two square inches of metal (at a liberal estimate) was left to do the work for which 13.68 sq.in. had been provided (Fig. 2).

Assuming the load on the bridge at 60 tons at the time of failure, the stress in the remaining section of the diagonal would have been 71,000 lb. per sq.in. The failure of this member would cause the settling of the span, which was noticed and would increase the load in the bottom chord nearly 100%. The bottom chord probably broke next; but fortunately at about the same time the dropping of one end of the floor-beam, working through its rigid connection to the post of the other truss, pulled the top chord of the upstream truss out of line and caused its failure. This allowed the span to settle evenly, instead of overturning the trolley cars and men into the river.

There are numerous other fractures of both top and bottom chords in both trusses, but these are clearly secondary. The rivet holes were evidently punched full sized; and when bent by the truss distortion, both top and bottom chords ripped apart, the breaks starting at these rivet holes.

Comments on Failure by Mr. Godfrey

Mr. Godfrey's comments follow:

The writer was in Johnstown on other work, two days after the accident, and he took occasion to give the bridge a casual examination. Enough was seen in the few minutes available to convince the writer that the cause of the wreck was simply deterioration that could readily have been discovered by careful inspection or that could have been prevented by proper design as regards the flooring of wood.

The bridge was supported by pony trusses of the Warren type with vertical hangers. The chords were double and well separated so as to give good stability laterally. There was one car track at one side of the bridge. This track was lined with loaded cars when the bridge dropped, and only the short distance that it had to fall prevented an awful disaster. I am told that the local theory of the collapse is that the top chords gave way first. This is totally untenable, for the top chords are not crumpled or buckled, but are torn apart and open at the breaks.

The wooden guard rail of the bridge was close up against the truss members, even being notched out so as to fit snugly against the wide flanges of the angles, which were turned with the backs outward. I observed the hip hanger and the first main diagonal where these had lain against the guard rail. They were broken at this level, and the metal was rusted away so badly that the thickness was $\frac{1}{16}$ in. or less. They looked about as thick as cardboard. The metal had a scale about $\frac{1}{4}$ in. thick.

The writer believes that the first thing that happened was the ripping of these "paper" hip hangers, then the failure of the first main diagonal at the level of the guard rail. This would leave three panels of the bottom chord acting as a beam. This would quickly break and let down the floor. The truss shoes did not leave the abutments.

Annual Meeting of the Boston Civil Engineers

The annual meeting of the Boston Society of Civil Engineers was held on Mar. 15 at the Boston City Club. The business meeting was called to order at noon, and the routine business of hearing the annual reports of the officers was transacted.

It was announced that the society's so-called "Permanent Fund" had reached the amount of $37,475.69 and that in addition to this there had been established the "E. K. Turner Fund" of $1,000, the income of which will be used for library purposes. The total revenues of the society for the year were $9,272, and they were $768 in excess of expenditures, indicating that the society is on a very satisfactory financial basis.

The thirty-fourth annual dinner was held in the main banquet hall of the Boston City Club at 1:30 p.m. and was followed by the announcement of the election of officers for the ensuing year, as follows: President, Richard A. Hale, Principal Assistant Engineer, Essex Water Power Co., Lawrence, Mass.; vice-president, Lewis M. Hastings, City Engineer, Cambridge, Mass.; directors to serve for two years, A. W. Dean, Chief Engineer of the Massachusetts Highway Commission, and S. E. Thompson, consulting engineer, Newton Highlands, Mass. S. E. Tinkham (secretary) and F. A. Whitney (treasurer) were reëlected. In the evening the annual smoker was held at the same place, and a buffet supper was served.

The Desmond Fitz Gerald medal for the paper of greatest merit presented before this society during the year was awarded to William S. Johnson, Boston, for his paper on "Ground-Water Supplies," which was published in the issue of the society's *Journal* for May, 1915.

Railway Engineering Society Has Active Meeting

SYNOPSIS—Report of annual meeting of American Railway Engineering Association at Chicago, Mar. 21-23, 1916.

In a remarkably active meeting the American Railway Engineering Association laid the foundation for much work in the coming year, but added only a few items to its prior standards of track and structures. The three leading subjects of the meeting were clearance, rails and steel bridges. In the first of these a most important standardization was accomplished by the adoption of a new general clearance diagram recommended as a minimum for all future railway construction. The subject of rails produced a remarkably interesting piece of information in a full report on a new acceptance test for steel rails, claimed by its author to be far ahead of the conventional acceptance tests. A new impact formula for steel railway bridges was brought forward as the ultimate product of the association's experimental study of impact stresses, and at the same time an exhaustive review of working stresses was presented by Prof. F. E. Turneaure.

Nick-and-Break Test for Rails

Robert W. Hunt and C. W. Gennet, Jr., gave a full report on the successful application of Mr. Hunt's nick-and-break test for steel rails. United States rolling mills had refused to take orders in which this test governed acceptance, but a Canadian mill that was short of work agreed to use the test for 10,000 tons of rails for the Canadian Pacific Ry., and later for 15,000 tons for the Illinois Central and 3,000 tons for the Rock Island. The results were satisfactory, not only to the railways, but also to the mill. The authors endeavored to prove by figures that the test is a surer detector of bad steel than the drop test now standard or than the drop test supplemented by chemical analysis for segregation, as used last year by the Pennsylvania R.R.

The test requires that the top end of every top rail—that is, a top-of-ingot specimen from every ingot—be nicked and broken and the top rail rejected if interior defects are seen on the fracture. In the latter case the bottom end of the top rail is similarly tested, to govern the acceptance of the next (B) rail; and if this is rejected, its bottom end is used to test for the next (C) rail, etc. Thus, every rail is accepted on the basis of a satisfactory fracture obtained higher up in the ingot; and what is most important, every ingot is tested.

The authors show by figures that the application of this test resulted in saving many rails that would have been rejected under the standard specifications. At the same time the test revealed dangerous defects in many rails that would have been accepted under the standard practice of testing only one ingot out of each heat.

Discussion of the paper brought various expressions of opinion, generally approving, from railway men, but no word from any representative of steel manufacturers. W. C. Cushing made the principal remarks in criticism of the nick-and-break test, which he condemned as not scientific, since it depends not on measurement, but on visual judgment of the inspector. He declared, further, that progressive improvement in rail specifications—which he described as a continuous struggle, a struggle still on—has brought about many improvements in mill and ingot practice and should continue to have this effect, and also that the chief present problem is improvement, not of rail specifications, but of ingot manufacture.

The report of the association's Committee on Rail offered no specific results or conclusions except on transverse fissures. This subject was studied by tabular analysis of very many chemical and other examinations of rails, including over 100 rails containing transverse fissures. The subcommittee concludes that (1) transverse fissures occur indiscriminately over the several rails of the ingot, (2) segregation is not an important factor in causing the fissures, and (3) the present problem is to determine the origin of the nucleus from which such a fissure grows.

A New Clearance Diagram

An intense practical discussion arose over the subject of clearances, and unlike most floor discussions it resulted in the definite acceptance of a new clearance diagram intended for universal application to new railways. That this action was accomplished appeared to be due largely to the firm guidance of the meeting by the president, Robert Trimble.

Recently, there has been much agitation in legislatures and in utility commissions in favor of increasing the clearances of railways, with a view to promoting the safety of railway employees. The American Railway Association called upon the engineering association to recommend a general clearance diagram. The Committee on Rules and Organization studied the question fully and as a result proposed a diagram involving a clearance width of 16 ft. and a height of 22 ft. The meeting considered this proposal, but rejected it. It also rejected a counter-proposal by C. W. Cushing, to fix the width at 14 ft.

For the lower part of the diagram, up to a height of 2 ft. above top of rail, the previously adopted diagram for electrified railways was accepted as a general standard. For the main part of the diagram a clear width of 15 ft. and a clear height of 22 ft. above top of rail, or 22 ft. 6 in. above base of rail, was accepted. The width of full-height clearance was made 8 ft., and the upper limit of full-width clearance was made 16 ft. above top of rail, or 16 ft. 6 in. above base of rail. The lower corner of the diagram was not definitely fixed.

A New Impact Formula for Steel Bridges

A monumental treatise on working stresses for steel bridges was presented by Prof. F. E. Turneaure as part of the report of the Committee on Iron and Steel Structures. He made no specific recommendations, but his presentation of a new impact formula has virtually the effect of a recommendation. The formula is intended to summarize the results of the impact-stress measurements made by the committee and all prior results on

the same subject. The impact factor is of the type of the Rankine-Gordon formula and is:

$$k = \frac{1}{1 + \frac{l^2}{30{,}000}}$$

in which k is the factor that, when multiplied by live-load stress, gives the impact-stress addition; l is the loaded length of bridge, giving maximum stress in the members under consideration. This formula gives lower values than most other formulas in the range above 150-ft. span length and lower values than the association's present standard formula for all spans exceeding 100 ft., but slightly higher values for shorter spans. This interesting contribution to bridge science was not discussed by the meeting.

The oft-disturbing subject of rerolled-rail bars for reinforced-concrete work came up at the meeting in a surprising way. It brought on a short and sharp discussion that was terminated by the chair on common-sense grounds.

Details of Masonry Construction

The Masonry Committee has a subcommittee delegated to the well-known "Joint Committee on Concrete and Reinforced Concrete," and the latter body is just now grappling with several highly contentious matters, one of them the question of rerolled-rail bars. The subcommittee asked instructions from the association on this question, specifically whether such bars are on a par with high-carbon bars made from billet steel, whether they are permissible in reinforced concrete generally or whether they are permissible where bending is not required. T. L. Condron made a strong argument in favor of considering rerolled-rail bars equivalent to billet-steel bars, but many other members took an opposing or a doubting attitude. The chief point brought out in the discussion was that such defects as transverse fissures in the rail (an actual separation of the steel) will not be welded up in the rerolling to make small bars. Dr. P. H. Dudley affirmed this explicitly in answer to queries. It was finally suggested that the subcommittee should settle the question for itself. A motion expressing this view was carried.

A detailed set of instructions for various kinds of surface finish for concrete was presented by the Masonry Committee. A proposal was made to adopt these as standard specifications, but criticisms and comments soon showed that revision would be needed, and the subject was thereupon referred back for report next year.

Discussion on surface washes (the committee condemned their use) led C. S. Churchill to speak in their favor, on the score of successful use on brickwork. It appeared, however, that he referred to such applications as Sylvester's wash, while the committee referred to cement wash. Many members reported that they had very unsatisfactory results from cement-wash surfacing; alligator-checking, cracking and scaling were observed after a few years.

On the question of tooled surfaces George J. Ray advised that no days' work joints should be allowed in a surface that is to be tooled. A bad streak or mark at such a joint is unavoidable. The Lackawanna now requires all retaining walls to be concreted the full height continuously. Elsewhere, days' work separations are concealed by paneling, belt courses and the like.

In the field of timber the chief action was adoption of the new grading rules for yellow pine, under which the material is classified by width of annual rings into "dense" and "sound" pine instead of botanically into long leaf and short leaf. The rule has already been adopted by the Forest Service, the American Society for Testing Materials and numerous other organizations producing or using yellow-pine lumber.

The Committee on Wood Preservation reported that after elaborate experiments on sampling creosote oil in tank-cars it has not discovered a method under which the amount of water in the oil would be determined correctly. It also has begun study of the relation between depth of penetration of preservative and resistance of the timber to decay. The meeting did not enter into discussion of these subjects.

The Baltimore & Ohio will shortly apply the Taylor system to all the track and maintenance work on its entire line from Philadelphia to Chicago. Several divisions are already operating under it. The system was worked out by Earl Stimson, Engineer of Maintenance. He read a paper describing the methods in detail.

Essential elements of the system are detail rating and subdividing of work and apportionment of fair tasks; systematic scheduling of work for week, month and season; instruction cards fixing the operations to be performed in each elementary task; establishment of standard times for the performance of the elementary tasks; records of performances; payment of bonus for performances in excess of the average.

A novel feature of Mr. Stimson's plan is that the standard times fixed for the several operations are not themselves the bonus limit. Average performance has been found to be about 67% of the standard times that were promulgated, and bonus is paid for monthly performance in excess of this average. The foreman and each laborer receive bonus in proportion to their rates of pay. In contrast with Mr. Taylor's practice the bonus rates appear to be low. In a case cited by Mr. Stimson to show the extra earnings by bonus the foreman received about $12 and each laborer about $6 bonus for the month.

The discussion was largely interrogatory. There was some appreciative comment, but also a number of doubts were expressed as to the permanent success of the system in practice.

Study of Foundations

Two committees of the association are dealing with foundation matters. The Ballast Committee is studying allowable unit pressures on roadbed subgrade. The Masonry Committee is studying the broad subject of "Design of Foundations for Piers, Abutments, Retaining Walls and Arches in Various Soils and Depths of Water, Not Considering Pneumatic Foundations." Neither committee has made any headway apparently. A form of report for tests of foundation soils is to be prepared soon by the second committee; presumably this will include instructions as to how to make such tests.

The Special Committee on Stresses in Railway Track reported that field tests so far made appear to give definite values for stresses in the rails and for the distribution of loads. The spacing of the locomotive driving wheels has an important effect upon the stress developed. The rail stresses appear to increase with speed of train, the static stresses holding only for speeds below 5 mi. per hr.

The Committee on Yards and Terminals submitted details of cost of operating flat and gravity yards. The discussion indicated that damage to equipment is less by the latter system of switching. It also submitted detailed tentative specifications for track scales.

Various Matters of Interest

The proceedings of the meeting contained many smaller items, each of great interest. Thus, President Robert Trimble in his address made a careful review of the common complaint that railway terminals and main stations are planned and built on too luxurious and expensive a scale. Taking the proposed Union Station in Chicago, which will cost about $50,000,000, he showed that all but possibly $2,000,000 is required by directly necessary expenditure, so that entire suppression of architectural elaboration, etc., could not save more than a few per cent. of the total. The annual charge for this extra expense, he said, will be only a few hundred thousand dollars, which if used for newspaper advertising would buy only a moderate amount of publicity.

J. L. Campbell, of the Water Service Committee, who has conducted careful tests of corrosion of various iron samples in the last three years, reported that, as a general result, these tests must be described as inconclusive. They have validity for the particular conditions only under which the samples were exposed. This statement is of direct interest, because in these tests various "pure irons" showed no advantage whatever. He also, by request, quoted the representative of the maker of one of these "pure irons" as stating that he would not recommend his metal for use under the corrosion conditions prevailing in Mr. Campbell's tests.

The question "What is gravel?" has come up in several discussions, and it came up here in relation to ballast. The Committee on Ballast compared stone, slag and gravel without qualification, but it was at once objected that there are various kinds and qualities of each material. The matter was referred back for further consideration. Of greater interest was that part of the discussion which related to ballasting by contract—a practice which is increasing. It appears to be favorably regarded in railways that have employed it.

Designs for drive and screw spikes were recommended and adopted. It was pointed out that, as screw spikes are as yet used to a limited extent only, now is the time to recommend a design. This need applies especially to the thread, as damage to the tie will result where a screw having one form of thread is replaced by one having another form.

A water-filled ashpit for engine terminals was an interesting feature submitted by the Committee on Buildings. The Rail Committee submitted specifications for splice bars and bolts of carbon steel and alloy steel. These specifications require the bars to be punched hot without distorting the form, but Mr. Sullivan considered it impossible to do the hot punching without distortion. The specifications were held over until next year.

The election of officers of the association for the coming year resulted as follows: President, A. S. Baldwin, Chief Engineer of the Illinois Central R.R., Chicago; vice-presidents, J. G. Sullivan, Chief Engineer of the Canadian Pacific Ry., and C. A. Morse, Chief Engineer of the Rock Island Lines. The secretary, E. H. Fritch, 900 South Michigan Ave., Chicago, was reëlected.

A New Profession*

By O. E. Carr†

Opportunity, disguised as municipal need, is knocking at the doors of the engineering profession today. She has but one warning. Qualify! Qualify not only in technical knowledge of the profession, but in ability to place that knowledge clearly and interestingly before men—not only for the good of the engineers themselves, but for the success of the city-manager plan.

In 1907 the Shenandoah River in flood time caused a bad washout at the City of Staunton, Va. Local contractors fixed the damage at $4,000. One of the council had action on repairs deferred until he could consult his friend, the division engineer of the railroad. The engineer came, saw and estimated $700 as the amount of the damage. Repairs were actually made for $650. Staunton affairs might have gone on in the same way after this incident as before, but they did not. An accident had placed the matter in a new light before thinking men. The result was that on Jan. 13, 1908, the council of Staunton passed an ordinance of far-reaching import—it provided for the first city manager, equipped with executive powers. Under its provisions the young division engineer previously referred to was put in charge of the affairs of the city. He was Charles Ashburner, first city manager in America, now serving in the same capacity at Springfield, Ohio.

In January, 1913, the want columns of the engineering magazines contained an advertisement, also the first of its kind in America. It was a call for a city manager, from Sumter, S. C. Things had come to a pretty pass politically among us—a city was seeking efficiency. The year 1913 added eleven cities to those pledged to the commission-manager plan and indicated that the movement was to become general. Today, 80 cities are committed to commission-manager government. The smallest is Morris, Minn., with 1,200 people; the largest, Dayton, Ohio, with a population of 150,000.

The new profession has had its acid tests. As first instituted, in spite of accepted efficiency the Dayton government faced recall petitions from disgruntled politicians. The manager of Phœnix, Ariz., went too far ahead of the ideas of his council in weeding out inefficient employees and buying expensive apparatus. Cadillac, Mich., through the agencies of politicians, faced a recall, but the administration was sustained three to one. San Diego, Calif., unearthed through its manager a "gentlemanly agreement" whereby the council had authorized the turning into the city mains of $8,000 worth of dirty, unfiltered water per month. In spite of his protests he was ordered to use the water, notwithstanding that an ample supply of pure water was already in the mains. Eighty cities have, or will have, managers, and the movement is growing. Out of the 40 managers appointed concerning whom we have been able to secure information, 30 are engineers by profession. Since the greatest activity and the greatest outlay of the public money are in connection with public utilities and improvements, it would seem that the appointees should be from that class of men whose education and experience have best fitted them for the positions.

*From an address delivered before the Washington Society of Engineers, Washington, D. C., Mar. 15, 1916.

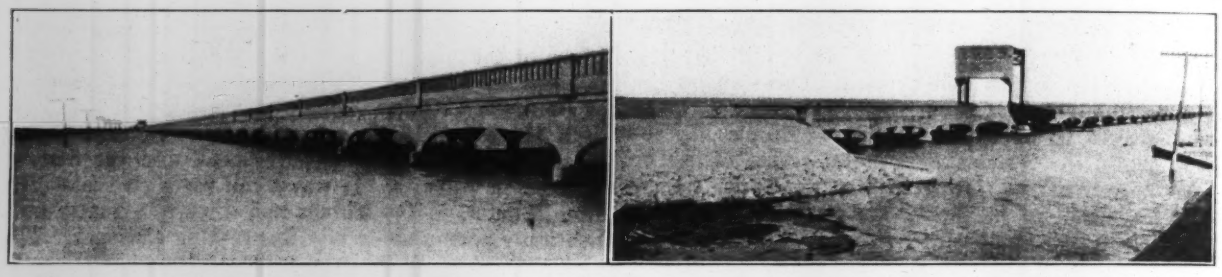
†City Manager, Niagara Falls, N. Y.

News of the Engineering World

Causeway at Corpus Christi Is Completed

The Corpus Christi causeway, connecting Nueces and San Patricio Counties, Texas, has just been completed by Nueces County at a cost of $165,000. The causeway crosses the neck of water connecting Nueces and Corpus Christi Bays, 30 mi. inland from the Gulf of Mexico, and consists of a concrete highway bridge 2,532 ft. long and a fill approach 6,200 ft. long, making a total length of 1.66 mi. San Patricio County has constructed simultaneously 3 mi. of hard-surface approach highway.

The bridging consists of 76 spans of 30-ft. clear and 32½-ft. centers, together with a 42-ft. lift span of the Strauss type, with a clear channel of 32 ft. between fenders. The bridging is designed for heavy highway loads and has a width of 19 ft. between curbs. There are no sidewalks. The piers rest on creosoted piling, 24-lb. treatment, with a concrete cap extending down to the present bottom. The spans are carried by four reinforced-concrete girders. The outer girders have elliptical arch shapes, and the inner girders are corbeled. The floor is a reinforced slab covered with a bituminous traprock surfacing. The rails are of ornamental concrete.



TWO VIEWS OF THE CORPUS CHRISTI CAUSEWAY BETWEEN NUECES AND SAN PATRICIO COUNTIES, TEXAS

The fill has a top width of 40 ft., with 1 on 6 side slopes, which approximate the natural beach slopes of the sand spits at each end of the causeway. The entire fill is of oyster shell, which was placed by hydraulic dredging from the shell reef that underlies the entire structure. The slopes are protected by continuous mats of brush fagots built into the toes of the fill and on the exposed side by a heavy apron of riprap. As soon as traffic has packed the shell surface, it will be covered by a mat of traprock with bituminous binder. The floor of the bridge is 7 ft. and the top of the fill 5 ft. above maximum high water in the bay.

The approach highway built by San Patricio County consists of a 4-ft. fill along a natural sand spit. The road surfacing is 12 in. of shell protected by a 2-in. bituminous rock mat.

The work in both counties was designed and built under the supervision of Bartlett & Ranney, Inc., Consulting Engineers, San Antonio and Dallas, Tex. The main contractor was W. L. Pearson & Co., Houston, Tex.

New York Has State Military Engineer Reserve

The "New York State Engineers Reserve" was formed in Albany at a recent meeting of about 150 engineers—representing the State Engineer, Highway Department, Conservation Commission, State Architect, State Board of Health, Public Service Commission, Albany City Engineer and men in private practice. A committee on organization was formed with about 25 members. This met Mar. 4 and elected C. A. Sussdorff, Deputy State Architect, as chairman, and G. V. Sweet, of the Highway Department, as secretary. A subcommittee (A. McKim, chairman) appointed to draft a constitution submitted a constitution to the Organization Committee on Mar. 11, which was passed. It was ratified at a meeting held Mar. 21.

The constitution states that the objects of the organization shall be the training of engineers for volunteer military service by the study and practice of military engineering, drill and field-service regulations. The membership is divided into four classes—active, associate, Army-Navy-National Guard reserve and honorary. The active members may be male citizens of the state qualified for military service and actively engaged in engineering work. Associate members may be active members who have served three years, men who have failed to meet physical requirements for active membership or members who because of activity in the National Guard may not become active members. The Army-Navy-National Guard reserve members are to be commissioned officers of the indicated organizations stationed or sojourning within the state. An honorary member may be any public-spirited citizen who contributes $50 to the organization.

An advisory staff of five members is provided to direct instruction. It consists of the president, two officers of the United States Army and two officers of the State National Guard. Nine or more active members may form a local unit in any city or village of the state, and this unit must drill at least once a week and have lectures twice a month. Active members are obliged under penalties to attend at least one drill and one lecture each month, which drills and lectures will be held regularly.

Steel Plant for Chattanooga

A $2,000,000 corporation known as the Chattanooga Steel Co. was formed very recently, the charter having been filed Mar. 7. The promoters are desirous of having the plant in operation by Sept. 1 and have already let some of the contracts. The works will be located north of the Tennessee River on a 100-acre tract, which will provide ample space for expansion. This location gives nearly ½ mi. of river front, besides physical connection with the railways entering Chattanooga. H. F. Wiltse, secretary of the Chattanooga Chamber of Commerce, informs us that "with this river location the company can count on coal by river at a rate of 10 to 12c. per ton as against a minimum of 40c. by rail. On finished products the company can count on a rate to Ohio River points of not to exceed $1.50 a ton on bloom or billets. This will place the company's product in St. Louis on a water rate of not to exceed $2.25 per ton, and for Chicago delivery not in excess of $2.60 per ton."

There will be two 75-ton openhearth furnaces producing a maximum of 336 tons per day. The blooming-mill capacity will be 1,000 tons. The buildings will be of concrete and of steel. Electric power will be used throughout, energy being purchased from the Chattanooga & Tennessee River Power Co., which operates the famous Hale's Bar hydro-electric development. It is stated that the completed plant will cover an area of 2,800x200 ft. and employ a force of 1,800 men.

Chattanooga and its immediate vicinity will provide sufficient pig iron, scrap iron and steel to feed the mill. The Chattanooga Iron and Coal Corporation is now producing at least 200 tons of pig iron daily. The mill will be built and equipped under the supervision of the W. R. Miller Co., Pittsburgh.

Minnesota Counties Take Over State Highway Engineers

The Minnesota legislature at the last session reduced the appropriation for the state highway commission from $210,000 to $100,000. This went into effect Aug. 1, 1915; but in order to complete work under way, the engineering forces were not materially cut until the close of the season.

Of the 86 counties in the state 50 have now taken over the state's engineers in their respective counties, 27 have passed resolutions authorizing the employment of the state's engineers, and four counties have signified their intention of doing so. This leaves only two counties not heard from, omitting Hennepin (Minneapolis), Ramsey (St. Paul) and Cook (Duluth), which have their own highway organizations. This showing is remarkable from the fact that three years ago the state highway commission practically forced the counties into line in accepting state-engineering supervision of road and bridge work done under the one-mill state tax and placed an engineer of its own in charge in each county. It also speaks volumes for the excellent engineering organization and the constructive engineering work done by George W. Cooley, state engineer, in this short time. Some of the counties in which the greatest hostility was shown to state supervision were the first to take over and assume the salary of the state highway engineers rather than go back to the former system, under which road work was done practically without engineering supervision or, if any, of a very low grade. It also develops the fact that the members of the state legislature were not in touch with the trend of public opinion regarding better roads and some scientific method of maintenance.

The state road and bridge fund raised by a one-mill tax amounts to approximately $1,500,000 a year. This is apportioned throughout the state under a law that provides for a minimum of 1% and a maximum of 3% to any county. Hennepin (Minneapolis), Ramsey (St. Paul) and Cook (Duluth) Counties together contribute half of the fund. Their allotment for this year is $35,000 each, or 2⅓% (7% total) of the fund.

Many Bidders on Dayton Concrete Bridges

Bids for three concrete bridges at Dayton, Ohio, opened on Mar. 15, showed a great eagerness on the part of contractors to get this sort of work. The three bridges are the Fifth St. bridge over the Great Miami River—seven 81-ft. arch spans, total length 611 ft., width 58 ft.; the Keowee St. bridge over the Mad River—three 91-ft arch spans, total length 289 ft., width 58 ft.; and the Webster St. bridge over the Mad River—about the same size as the Keowee St. bridge.

On the first of these bridges, there were 18 bidders; the low bid was $116,930, the high bid $188,570. On the second there were 21 bidders; the low bid was $61,014.30 and the high bid $136,282.50. On the third there were 24 bidders; the low bid was $61,796.80 and the high bid $112,837. Taking account of deductions of $2,000 if awarded the larger bridge and either one of the smaller and of $5,000 if awarded all three bridges, the Pacific Bridge Co., Portland, Ore., had a low combination bid of $239,026.50 for all three bridges. It was awarded the contract for all three bridges on Mar. 25. The itemized low bids for each bridge and the bids of the Pacific Bridge Co. are given in the pages of Construction News of this week.

Chance for a Good Engineer

What might perhaps be termed a modified city-manager plan so far as combining a number of important executive positions in one is to be tried at Ottawa, Ont. That city, through Norman H. H. Lett, city clerk, is inviting applications up to Apr. 10 for a position officially named City Engineer and Commissioner of Works. The appointee will also fill the position of Water-Works Engineer of the city. The salary will be $6,000 a year. All applications must be accompanied by a statement of qualifications and experience.

Engineers' Attitude Toward Preparedness

A resolution defining the attitude of engineers toward the policy of national defense was adopted by acclamation by an audience of 3,000 engineers in New York City who are attending a series of lectures on military engineering. The resolution is as follows:

The engineers assembled in public meeting on Mar. 20, 1916, under the auspices of the Engineers' Committee on Military Lectures, believe that it is unworthy a great nation like the United States and that it is dangerous to the peace, safety

and liberty of its people to remain in our present position of inadequate military, naval and industrial preparedness.

We believe that between pacifism and militarism there is a just, safe and proper ground, greatly in advance of our present position—a ground which involves large additions to both the navy and army, a large increase in our schools for training officers and a coördination and mobilization of the physical and industrial resources of the nation.

We believe that this nation should never make war except to enforce peace; that when strongly supported by armed resources its influence in maintaining its own liberties and rights and the liberties and rights of the weak and oppressed throughout the Americas will be greatly strengthened.

We believe that Congress should give due weight to the opinion of experts and should then appropriate sufficient money to put the nation in a position of defense against attack on either the Atlantic or the Pacific Coast. We demand that our representatives in Congress act in accordance with this expression.

Sixteen Sewer-Construction Crews at Minneapolis will soon begin on $600,000 worth of new sewers for that city. Two of the crews will work on tunnel and catchbasin construction. Carl Ilstrup is city sewer engineer.

Municipal Improvements for San José, Costa Rica, at a cost of $2,000,000, will be made if Carlos O. Castro, member of the City Council, who arrived in New York on Mar. 27, succeeds in placing a loan for that amount. The money will be used for extending the water-works, for paving and for a garbage-disposal plant. Mr. Castro's temporary address is Office of Bureau of Foreign and Domestic Commerce, Custom House, New York City.

A Report on Remedies for the Pollution of the Detroit and Niagara Rivers has been completed by Earl B. Phelps, consulting engineer, International Joint Commission, Washington, D. C. The report, which is a final one, was considered by a meeting of the commission on Mar. 8 and 9. No action will be taken on it by the commission until there has been opportunity for its discussion by the municipalities, states and Federal officers interested. Public hearings will be held for the consideration of the report, which it is hoped will be available in printed form at a comparatively early date. The engineering department of the cities of Detroit and Buffalo, it is understood, have coöperated in the investigations upon which the report is founded.

The Mysterious Eye-Bar Failure that caused the wreck of the Division St. bridge at Spokane, Wash., on Dec. 18, 1915, has not been solved by the investigation conducted by the State Public Utilities Commission. The testimony of City Engineer Morton Macartney before the commission was that the bridge was designed for a maximum load of 18,000 lb. per sq.in. The load that could have been produced by two of the heaviest electric cars run over the bridge, in combination with two 10-ton motor trucks, might reach a maximum of 20,200 lb. per sq.in. The opinion of both City Engineer Macartney and C. J. Colgan, Engineer of the Public Utilities Commission, was that the accident was due to some defect in the steel eye-bars, but neither was able to give any definite opinion as to the character of the defect that might have caused the failure.

Prize Designs for Workmen's Dwellings, offered by the National Americanization Committee, were announced in "Engineering News," of Feb. 24, p. 390. The complete program of the competition is now ready for distribution, and some details have been altered from the original plan. The designs desired are grouped under four different classes. The first prize offered in each class is $300, and the second prize is $100. There is an additional prize of $200 in each class for excellence of construction. Competitors have until June 1 to submit their designs. The jury to award prizes is made up of J. Lawrence Mauran, President of the American Institute of Architects, St. Louis; Milton B. Medary, Jr., Architect, Philadelphia; Chester H. Aldrich and Grosvenor Atterbury, Architects, New York City; Dr. Caroline Hedger, New York City; John Ihlder, Secretary of the National Americanization Committee, Washington, D. C., and Morris Knowles, Consulting Engineer, Pittsburgh. Besides the prizes offered in the housing competition, prizes aggregating $600 are offered for the best design for boarding-cars for railway construction gangs. The Chairman of the National Americanization Committee is Frank Trumbull, Chairman of the Board of Directors of the Chesapeake & Ohio Ry. The headquarters of the committee are 18 West 34th St., New York City, and complete programs of the competition can be obtained from that address.

PERSONALS

Mr. H. A. Genung, Construction Engineer of the St. Paul Southern Electric Ry., has been appointed Chief Engineer.

Mr. Arthur M. Field, civil engineer, Rochester, N. Y., has been elected City Manager of Winchester, Va., with an annual salary of $2,000.

Mr. J. J. MacDonald, St. Paul, has been appointed Superintendent of the St. Paul Southern Electric Ry., to succeed Mr. Karl A. Schaller, who recently resigned.

Mr. Clarence C. Jacob, Assoc. M. Am. Soc. C. E., District Engineer of the United States Geological Survey, at Phoenix, Ariz., has been transferred to Salt Lake City, to take charge of the Utah district.

Mr. F. Z. Schellenberg, consulting engineer and geologist, announces that he is available for consultation with newly organized firm of Blum, Weldin & Co., St. Nicholas Building, Fourth Ave. and Grant St., Pittsburgh, Penn.

Mr. Edward M. Hagar, Assoc. M. Am. Soc. C. E., formerly President of the Hagar Portland Cement Co., Chicago, is now President of the Wright Co., 5 Nassau St., New York City, manufacturer of aëroplanes. Mr. Hagar's address is 60 Broadway, New York City.

Mr. C. F. Schulz, Commissioner of Water of the City of Cleveland, Ohio, previous to Mar. 1, 1916, will engage in private practice as a consulting engineer, giving especial attention to water-supply engineering and appraisal work. His address is 1906 East 105th St., Cleveland, Ohio.

Mr. Ernest McCullough, M. Am. Soc. C. E., Consulting Engineer, Chicago, has been made Chief Engineer, Fireproof Construction Bureau of the recently reorganized Portland Cement Association, 111 W. Washington St., Chicago. This bureau will disseminate knowledge and promote standardization of practice as relates the idea of building fire-safe.

Mr. Hiram N. Savage, M. Am. Soc. C. E., formerly Supervising Engineer of the United States Reclamation Service, has been appointed Consulting Engineer of the Sweetwater Water Co., San Diego, Calif. Mr. Savage will direct the design and construction of works required to restore and amplify the Sweetwater storage and distribution system, which was damaged by the recent floods in San Diego County.

Mr. J. B. Morlidge, formerly Commissioner of Public Works of Newport, Ky., has opened an office at 60 Mitchell Building, Cincinnati, Ohio, where he is engaged in the general practice of engineering. Mr. Morlidge held official positions in the City of Newport for a period of 12 years, first as City Engineer and for the past 4 years as Commissioner of Public Works. He is now specializing in pavements, highways and sewerage.

Mr. W. S. Baldwin, formerly in charge of the Construction Department of the Syracuse (N. Y.) Lighting Co., has been appointed Superintendent and Assistant to the Manager of the Harrisburg (Penn.) Gas Co. He succeeds Mr. C. M. Cole, who has been made Superintendent of the gas-manufacturing department of the Syracuse plant. Mr. Baldwin was formerly with the United Gas and Electric Co. and handled many of its large construction jobs.

Mr. J. C. Travilla, formerly Street Commissioner of the City of St. Louis, Mo., has been engaged as consulting engineer on the road-improvement work in St. Louis County, for which a $3,000,000 bond issue was recently authorized by the County Court. He will receive an annual salary of $4,800. The construction of the new roads will be under the supervision of Mr. Elbring, County Engineer. Mr. Travilla was connected with the Street Department of the City of St. Louis for about 15 years. Since 1913 he has been in charge of a million-dollar road construction in Tarrant County, Texas, which has just been completed.

Messrs. Louis P. Blum, M. Am. Soc. C. E., and William A. Weldin have formed a partnership under the firm name of Blum, Weldin & Co., with offices in the St. Nicholas Building, Fourth Ave. and Grant St., Pittsburgh, Penn. The firm will engage in general engineering practice, giving special attention to surveying of urban property, mineral lands, etc., railroad and municipal engineering and the design and construction of mill and other buildings, as well as complete industrial and mining plants. Mr. Blum for the past 14 years has been associated with the W. G. Wilkins Co., Pittsburgh, and previous to that connection he was engaged for 10 years in the Department of Public Works of Philadelphia. Mr. Weldin has been with the H. C. Frick Coal Co., George S. Baton & Co., the Jones interests (which include the Four States Coal and Coke Co., Pittsburgh-Buffalo Co., United States Sewer Pipe Co.) and the Pittsburgh Coal Washer Co.

OBITUARY

Gen. William Warren Stewart, Supervising Engineer of the Cumberland Valley R.R., died at his home in Chambersburg, Penn., on Mar. 18, at 80 years of age. In 1864 he was brevetted adjutant-general.

Patrick T. Walsh, head of the Walsh Construction Co., railroad contractor, Davenport, Iowa, died on Mar. 18 at his home in that city. He had been in the contracting business for 30 years, starting by digging cellars on contract.

John Ford Miller, former Vice-President of the Cleveland, Akron & Columbus Ry. (now the Cleveland, Akron & Cincinnati Ry.) and for many years Superintendent of the Pennsylvania Lines West of Pittsburgh, died at his home in Richmond, Ind., on Mar. 19, at 86 years of age. Mr. Miller was the representative of the Pennsylvania, which ended the Chicago strike of 1893.

Carl Robert Grimm, M. Am. Soc. C. E., formerly associated with the Tacony Iron and Metal Co., Philadelphia, Penn., died at his home at Rengsdorf bei Neuwied am Rhein, Germany, on Feb. 15. Mr. Grimm was personally and professionally associated with the late C. C. Schneider, Past-President of the American Society of Civil Engineers, and with Messrs. Gustav Lindenthal, New York, and Frederick Charles Kunz, Philadelphia. Mr. Grimm was author of a book entitled "Secondary Stresses in Trusses" and was designer, it is understood, of the steel framework that surmounts the Philadelphia City Hall tower, for which the Tacony Co. was the contractor.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Apr. 11-14. Spring meeting in New Orleans. Secy., Calvin Rice, 29 W. 39th St., New York City.

CONFERENCE ON ENGINEERING CO-OPERATION.
Apr. 13-14. Conference in Chicago. Secy., C. E. Drayer, Cleveland, Ohio.

AMERICAN CHEMICAL SOCIETY.
Apr. 18-21. Annual meeting at the University of Illinois, Urbana-Champaign. Secy., Charles L. Parsons, Washington, D. C.

NATIONAL ASSOCIATION OF COTTON MANUFACTURERS.
Apr. 26-27. One-hundredth annual meeting in Boston. Office of secretary, 45 Milk St., Boston, Mass.

AMERICAN ELECTROCHEMICAL SOCIETY.
Apr. 27-29. Annual meeting in Washington. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

AIR BRAKE ASSOCIATION.
May 2-5. Convention in Atlanta. Secy., E. M. Nellis, 53 State St., Boston.

CANADIAN RAILWAY CLUB.
May. Annual meeting in Montreal. Secy., James Powell, P. O. Box 7, St. Lambert, near Montreal.

RAILWAY DEVELOPMENT ASSOCIATION.
May 9-11. Annual meeting in New Orleans. Secy., H. O. Hartzell, B. & O. R.R., Baltimore, Md.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 9-11. Annual meeting in Chicago. Secy., Franklin H. Wentworth, 87 Milk St., Boston.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
May 10-12. Convention in Pittsburgh. Secy., F. D. Mitchell, 1510 Woolworth Building, New York City.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

New Hampshire Good Roads Association was formed in Nashua, N. H., on Feb. 24, with the following officers: President, Ovid F. Winslow; vice-presidents, Samuel F. Lord and Alfred Clark; secretary, George C. Winn, Nashua; the Board of Directors consists of M. N. Layn, C. A. French, F. N. Everett and A. A. Wallace.

Roadmasters and Maintenance-of-Way Association—The Executive Committee has appointed P. J. McAndrews (Roadmaster, Chicago & Northwestern Ry.), Sterling, Ill., as secretary, to succeed L. C. Ryan, who has resigned in consequence of having left railway service to go into other business.

American Institute of Electrical Engineers through its Board of Directors has selected the following list of "directors' nominees": President, H. W. Buck; for vice-presidents, L. T. Robinson, Peter Junkersfeld, B. A. Behrend and Henry A. Lardner; managers, John B. Fisken, Charles Robbins, N. A. Carle and Charles S. Ruffner; treasurer, George A. Hamilton. Of the four names mentioned for vice-presidents only three are to be elected. The ballots will be mailed to the membership before Apr. 1.

American Society of Mechanical Engineers will hold its spring meeting, Apr. 11 to 14, at New Orleans. The opening session will be on "Industrial Preparedness". There will be sessions also on "Engineering Problems of the South" and on "Measurement of Flow of Fluids". Entertainment features will include a stop-over at Birmingham on Apr. 10, en route to New Orleans, an excursion on the Mississippi River, with an inspection of the harbor facilities and the new cotton warehouses, and a reception on the afternoon of Apr. 13, followed by a ball.

North Dakota Society of Engineers at its eighth annual convention at Grand Forks elected the following officers: President, J. W. Bliss; vice-presidents, J. A. Ingram and H. C. Frahm; secretary, E. F. Chandler, University, N. D. The present membership of the society is 75. The next annual meeting will be held at Bismarck the latter part of January, 1917. At the meeting the members unanimously recommended that the next legislature provide for the licensing, upon proper examination, of public-land surveyors before they be entitled to work in the state.

A State Industrial Safety Conference was held in the Pennsylvania capitol at Harrisburg, having been called by Governor Brumbaugh and John Price Jackson, Commissioner of Labor and Industry. About 400 officials of Pennsylvania industrial plants responded. Some of the speakers were Samuel Gompers, William C. Wilson, James T. McCleary, Van Manning, William B. Dixon and C. L. Close. At the afternoon session committees were appointed by J. P. Jackson to consider safety measures for the various industrial branches, as follows: Steel trades, coal mining, railroads and general industrial plants.

Massachusetts Highway Association met at Ford Hall, Boston, Mar. 23. One hundred and sixty members and guests were present. James W. Rollins, president of the Holbrook, Cabot & Rollins Corporation, read a paper on "The Relations that Should Exist Between Engineers and Contractors," which was discussed by Colonel Sohier, chairman of the Massachusetts Highway Commission, Mr. Rowe, of the Rowe Contracting Co., and Edwin H. Rogers, city engineer of Newton. Another subject discussed was that of providing highways more suitable for horse-drawn traffic. A committee was appointed to confer with the Massachusetts Protective Association for Horses, to see what could be done in this direction. L. K. Rourke, of Rourke & Sherman, consulting engineers, Boston, the newly elected president of the association, presided.

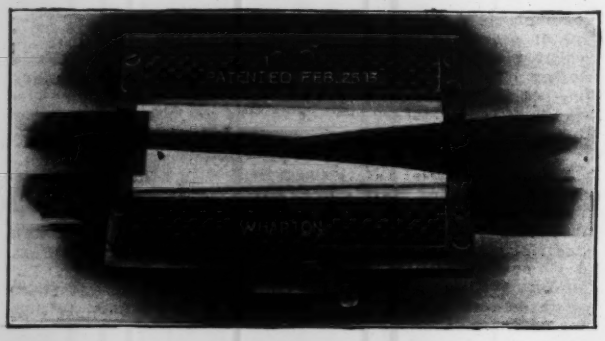
American Chemical Society will hold its fifty-second meeting, Apr. 18 to 21, at the University of Illinois, Urbana-Champaign, preceded by a meeting of the council on Monday evening, Apr. 17. The headquarters is the Beardsley Hotel. Some of the special and entertainment features are as follows: Brigade review on the drill grounds and inspection of the armory, smoker in the gymnasium annex of the university, reception and inspection in the new chemistry building, banquet at Masonic Temple, excursions to Hegeler Brothers' zinc smelter and sulphuric-acid plant, to the Western Brick Co.'s kilns and to the Three Rivers Coal Co.'s strip coal mines. Three of the papers scheduled are "Agricultural and Food Chemistry," by G. F. Mason; "Fertilizer Chemistry," by B. F. Carpenter; and "Water, Sewage and Sanitation," by Harry P. Corson. At the session of the Division of Water, Sewage and Sanitation there will be a final report by the Committee on Methods of Analysis of Water and Sewage and a symposium on activated sludge, for which papers have already been promised by H. W. Clark, W. R. Copeland, F. J. Fort, Calvin W. Hendrick, Arthur Lederer, W. D. Richardson and Robert Spurr Weston. The division will visit the iron-removal plant of the Champaign & Urbana Water Co. and the sewage experiment station of the Illinois State Water Survey. The local section of the society has invited the leading manufacturers of chemical products and apparatus of the country to participate in an exhibition, and the response thus far has been promising. The secretary is Charles L. Parsons, Box 505, Washington, D. C.

Arkansas Engineering Society held its fifth annual meeting in Helena, Feb. 22 and 23. Owing to the geographical location of Helena and the flooded condition of the Mississippi River, the papers and discussions were devoted almost entirely to river protection, levees and drainage. A considerable portion of the time was devoted to visiting and inspecting works of this nature. A banquet was held on the night of Feb. 22. The officers elected were: President, James R. Ryan; vice-president, Louis R. Parmalee; secretary, Wm. J. Parks, Pine Bluff, Ark.; directors for two years, Harry T. Simons and Hugh H. Humphreys. The next meeting will be held in Little Rock in the early part of 1917.

Appliances and Materials

Expansion Rail Joints

A track-expansion joint for electric railways, devised by William Wharton, Jr., & Co., Inc., of Philadelphia, has recently been used on bridges in the Pittsburgh district. The principal aim of the design is to give a continuous running surface on the tread and guard. This is secured through a taper on both head and guard sides of one of the connecting rails. As this tapered rail is loose, it slides in and out of the joint as expansion and contraction of the joint take place. On



WHARTON EXPANSION RAIL JOINT

both the tread and guard sides are manganese-steel wear plates that slide in and out, always held hard up against the tapered rail by heavy springs so as to fill the gap which would otherwise be left. When the rail returns, it forces the wear plates apart. The rails and plates are well supported in a cast frame designed so that there will be no accumulation of dirt, ice or snow.

* * *

New Attachable Dump Body

The "Lee" two-way side-dump body, illustrated herewith, was designed especially for use on the Jeffery "Quad" truck. The steel body is secured in position by two catches (in front and rear), by a stop on each side and by the three rails on

"LEE" HAND-OPERATED DUMP BODY

which it rolls in dumping. Each rail terminates in a hook, which acts as a final pivoting point when the body is dumped.

The view shows the body dumping. Tests have shown that the average driver can jump down from his seat, dump the load, replace and secure the body and return to his seat, ready for driving off, in 30 sec. The new body is manufactured by the Thomas B. Jeffery Co., of Kenosha, Wis.

Clamp for Wire-Ties of Forms

The clamp shown herewith is for tightening and holding wire ties in forms for concrete work. The wires are pulled through the form planks, no holes being required in the studs and the wires not being twisted within the form. The clamp is held flat against the stud, with its stem vertical above the wire tie, and the ends of the wire are slipped into the slots. There they are held in position by giving them a twist. Then the clamp is turned over, bringing its stem vertical below the wire tie. The wire is thus drawn tight, and its tension holds the clamp in position. A nail may be driven in the slot of the stem of the clamp to prevent its being displaced. The device is made in two sizes, one for use on 2-in. studding and the other for larger studding. It is manufactured by the American Metal Form Co., Fisher Building, Chicago.

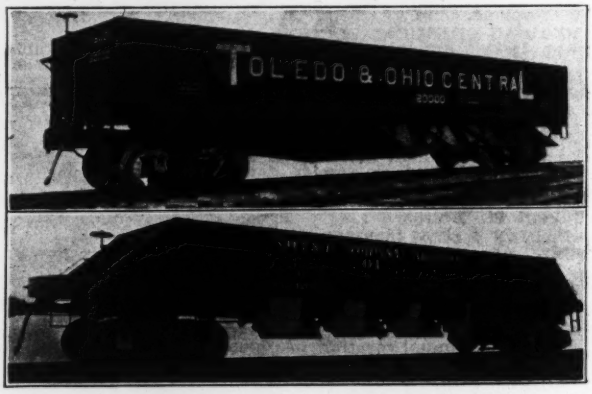
WIRE-TIE CLAMP FOR CONCRETE FORM

* * *

Side-Dumping Gondola Cars

A side-dumping gondola car is built by the Ralston Steel Car Co., Columbus, Ohio, two designs being shown in the accompanying views, adapted for both work-train and general-revenue service, so as to be kept in constant use. The notable feature is the drop floor.

The main member of the underframe is a heavy plate-girder center sill, with brackets and cantilever cross-bearers to carry the side stakes. In the spaces between the cross-bearers are doors or floor panels hinged against the center sill and supported at the outer side by a cranked rod, which is carried in bearings beneath the crossframes. There are two rods on each side, each extending half the length of the car, so that half the doors on either side can be operated independ-



DROP-BOTTOM SIDE-DUMP CARS FOR CONSTRUCTION WORK AND FREIGHT SERVICE

ently of the other. Each door rests on three rollers (mounted on the supporting rod), the middle roller traveling in a channel that forms a stiffener for the door.

The car of the Toledo & Ohio Central R.R. (New York Central Lines), which is shown at the top of the illustration, has a steel frame and wooden sides. It is of 50 tons' capacity, weighs 20 tons and is used mainly for hauling coal. In construction service these cars have been used in filling trestles (the load averaging 38 yd. per car; they are specially adapted to such work, as the material falls through the deck and does not foul the rails. As practically the entire bottom drops, the cars are self-cleaning. If used to widen banks by dumping at one side only, hand shoveling is required to empty the car.

The steel car of the Northern Ohio Traction and Light Co., shown in the lower part of the view, is of special design and is used mainly for hauling ashes from the company's power house. It has a hopper body with inclined ends and four drop doors forming each side of the bottom. The end sills are curved like those of the electric motor cars. The car is 42 ft. long over the frames and 30 ft. inside. It has a load capacity of 40 tons, or 783 cu.ft., and weighs 15½ tons.